Compressed Air Magazine

Vol. 41, No. 11 London - New York - Paris November, 1936

HAULING FUEL FOR A CANADIAN MINE

Compressed Air Magazine

NOVEMBER, 1936

Volume 41 **Number 11**

EDITORIAL CONTENTS

ADVERTISING INDEX

Business, Editorial and Publication Offices
PHILLIPSBURG, N. J.

Advertising Office
11 Broadway
NEW YORK CITY

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Annual subscription rate: Domestic, $3.00; foreign, $3.50. Single copies, 35 cents.

Manuscripts intended for editorial consideration should be accompanied by return postage.

COMPRESSED AIR MAGAZINE is on file in many public libraries and is indexed in INDUSTRIAL ARTS INDEX

The Buchanan Dam

G. W. Morrison

THE State of Texas is so large that even one who is reasonably well acquainted with the United States has difficulty in comprehending its enormous size and the wealth it possesses in its natural resources and its great variety of agricultural products.

Until the Colorado River of Texas went on one of its periodic rampages a few weeks ago, it is doubtful if many persons in other parts of the country had ever heard of it. And yet it is fully 500 miles long—exceeding in this respect such well-known streams as the Delaware, Hudson, and Potomac rivers. This particular river, which is not to be confused with the greater one by the same name on which Boulder Dam is situated, rises in Dawson County, in the west-central portion of Texas, flows southeastward, and empties into Matagorda Bay, which is an arm of the Gulf of Mexico.

In times of heavy rainfall upon the watershed of it and its many tributaries, the flow in the main river reaches serious proportions and does great damage. At several times in the past, notably in 1900, 1915, and 1935, floods have wrought havoc, particularly in the low-lying sections of Austin, the state capital, through which the river passes. In 1900 it washed out a portion of the Austin Dam. Its flow at that time was measured by the United States Geological Survey as 151,000 second feet, while the great surge that followed the failure of the dam was estimated at 236,000 second feet. Since that time larger floods have been recorded, the largest coming in June, 1935, when a momentary peak discharge of 481,000 second feet was reached. The flood of September, 1936, was smaller, but was great enough to do extensive damage.

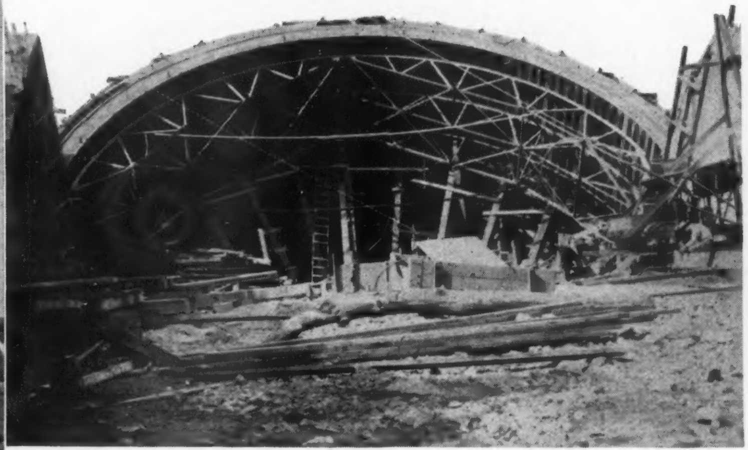
In the lower river valley there are approximately 600,000 acres of fertile land which, given water, would be suitable for rice culture. Irrigating water is now available for only 50,000 acres. Canals have already been constructed to 254,000 acres, but there is no water for 204,000 acres already having ditches. It requires approximately three acre feet of water per growing season to irrigate one acre of rice. Naturally, for many years it has been the dream and the ambition of leading residents of that particular section of Texas to bring about the storage of the flood waters of the Colorado River, thereby making them available for irrigation purposes and at the same time curbing the ever-feared flood menace to life and property.

As a result of much constructive work done towards this end by various interested individuals and groups, headed by Rep. Fritz Englehardt, the State Legislature in February, 1935, created a body known as the Lower Colorado River Authority. This embraces ten counties. It is vested with the rights to make use of the flood waters of the river for flood control, irrigation, water conservation, etc., and is clothed with the power to construct such engineering works as are needed to effect their utilization for such purposes. The Authority purposes to carry out a construction program that calls for the erection of such dams as may be required to conserve and put to beneficial use the flood waters of the Colorado River and its tributaries—waters that have caused an average annual property loss of $4,000,000 during the past two decades, not to mention the loss of life and the inconvenience and sorrow that have been suffered by persons who have been driven from their homes.

The Authority speedily organized an able, experienced staff to formulate plans and to put the work underway. Clarence McDonough, formerly director of engineering for the Federal Emergency Administration of Public Works, in Washington, was appointed general manager. R. B. Alsop, who is widely and favorably known among construction men, was made general superintendent. James Patterson and A. C. Cerney were named to superintend the two principal divisions of the work.

The program determined upon calls for the construction of three dams: the Buchanan, 80 miles northwest of and upstream from Austin; the Roy B. Inks, three miles downstream from the Buchanan; and the Marshall Ford, 26 miles upstream from Austin.

Before telling what is now being done to carry out this program, we shall revert to some previous construction work that has a bearing on the current activity. In 1931, private power interests instituted a plan of hydroelectric development on the Colorado River, the scheme calling for the building of three power plants in series, with the



MAIN SECTION

The center picture is a view from downstream of a portion of the partially completed 70-foot-span arch section. At the left is a close view of an individual arch, from the upstream side. At the right the same arch is shown as it appears from downstream. The arches are heavily reinforced with steel, and despite their relatively thin section will have great strength.

upstream unit to be erected first in order that its dam might regulate the flow of the river downstream from that point. This first dam was designated as the Hamilton Dam. The design for it was prepared by the Fargo Engineering Company of Jackson, Mich., which was also retained to supervise the construction. The contract was let to the Fegles Construction Company of Minneapolis, Minn., and work began in May of 1931. The estimated cost of the undertaking was $6,000,000. With the structure partially completed, the power company went into receivership, and operations halted.

When the Lower Colorado River Authority came into being it obtained title to the Hamilton Dam, now called the Buchanan Dam, and undertook to complete it. It is with the work now in progress there that this article is principally concerned.

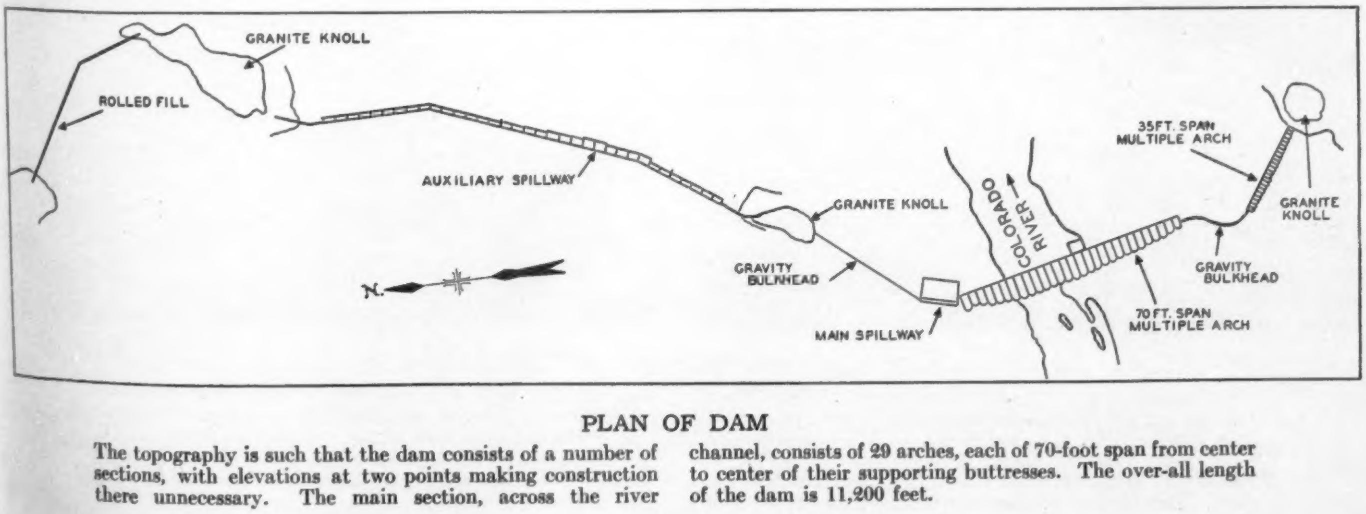
To carry out its 3-dam construction program, the Authority secured a grant of $4,500,000 and a loan of $10,500,000 from emergency funds of the Federal Government, the transaction being made through the Public Works Administration. In addition, the U. S. Bureau of Reclamation was allotted $5,000,000 to be spent on the undertaking as the Government's contribution in return for flood-control benefits. The total amount available is, therefore, $20,000,000.

A contract was entered into between the Authority and the Government whereby the Bureau of Reclamation was made the construction agency for the entire project. During the past summer, however, this contract was revised. Under the new agreement the Buchanan and Roy B. Inks dams will be built under the supervision of the Authority rather than of the Bureau of Reclamation. The Bureau will, however, retain direction of the construction of the Marshall Ford Dam.

At the time the second contract was signed, the Bureau of Reclamation had received bids for the construction of the Roy B. Inks Dam. In view of the change in jurisdiction, all bids were rejected by the Bureau of Reclamation, but the Authority subsequently awarded the contract to Morrison & Knudsen of Boise, Idaho, on its low bid of $783,773.50. That firm has already begun work. Details regarding the operations there will be presented in a future article. For the present it will suffice to mention that it is to be a straight gravity type structure, 1,700 feet long and 66 feet high, and will provide storage capacity in its reservoir area for approximately 30,000 acre feet of water. Bids were received on October 20 by the Bureau of Reclamation for the construction of the Marshall Ford Dam. This structure will be approximately 185 feet high and will create a reservoir having a storage capacity of some 700,000 acre feet of water.

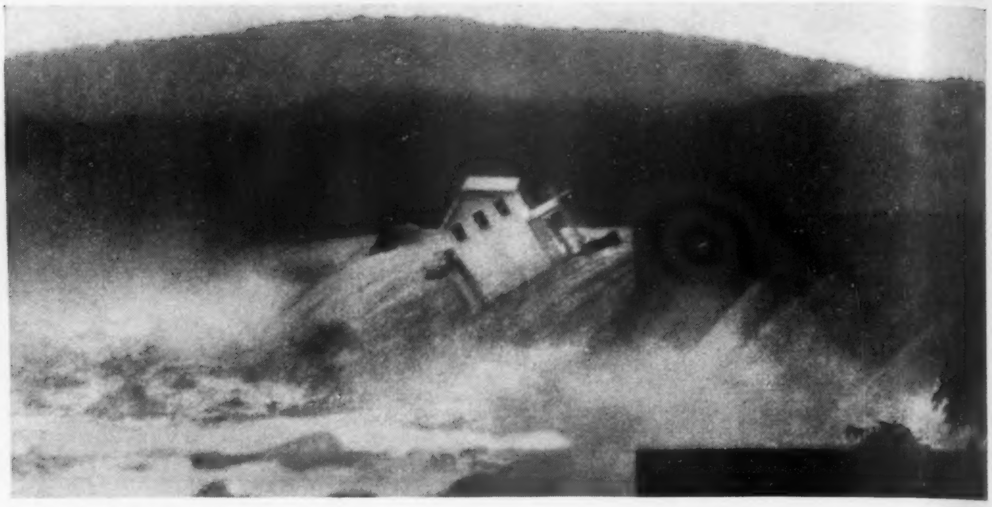
At Buchanan Dam, approximately 1,500 men are engaged in actual construction work, and 100 others are clearing the reservoir site which will eventually be flooded. This latter work is being done by Brown & Root, Inc., of Austin, Texas, under a contract for $323,350, which was awarded previously by the Bureau of Reclamation. It calls for clearing 16,800 acres.

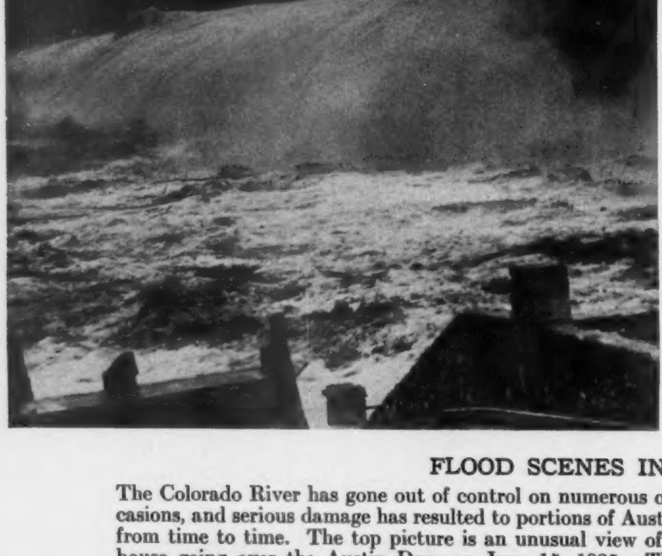
The drainage area of the river system above the dam is approximately 31,250 square miles. The average annual flow that can be classed as flood waters exceeds



PLAN OF DAM

The topography is such that the dam consists of a number of sections, with elevations at two points making construction there unnecessary. The main section, across the river channel, consists of 29 arches, each of 70-foot span from center to center of their supporting buttresses. The over-all length of the dam is 11,200 feet.





FLOOD SCENES IN THE CITY OF AUSTIN

The Colorado River has gone out of control on numerous occasions, and serious damage has resulted to portions of Austin from time to time. The top picture is an unusual view of a house going over the Austin Dam on June 15, 1935. The center picture shows South Congress Avenue after the 1935 flood. The photograph that is reproduced at the lower left was taken at the instant a portion of the Austin Dam went out in 1900. The street car came to grief in September 1915. One of the chief purposes of the construction of dams is to prevent the recurrence of scenes of this sort. The annual flood damage of the Colorado River in Texas has been estimated at as much as $5,000,000.

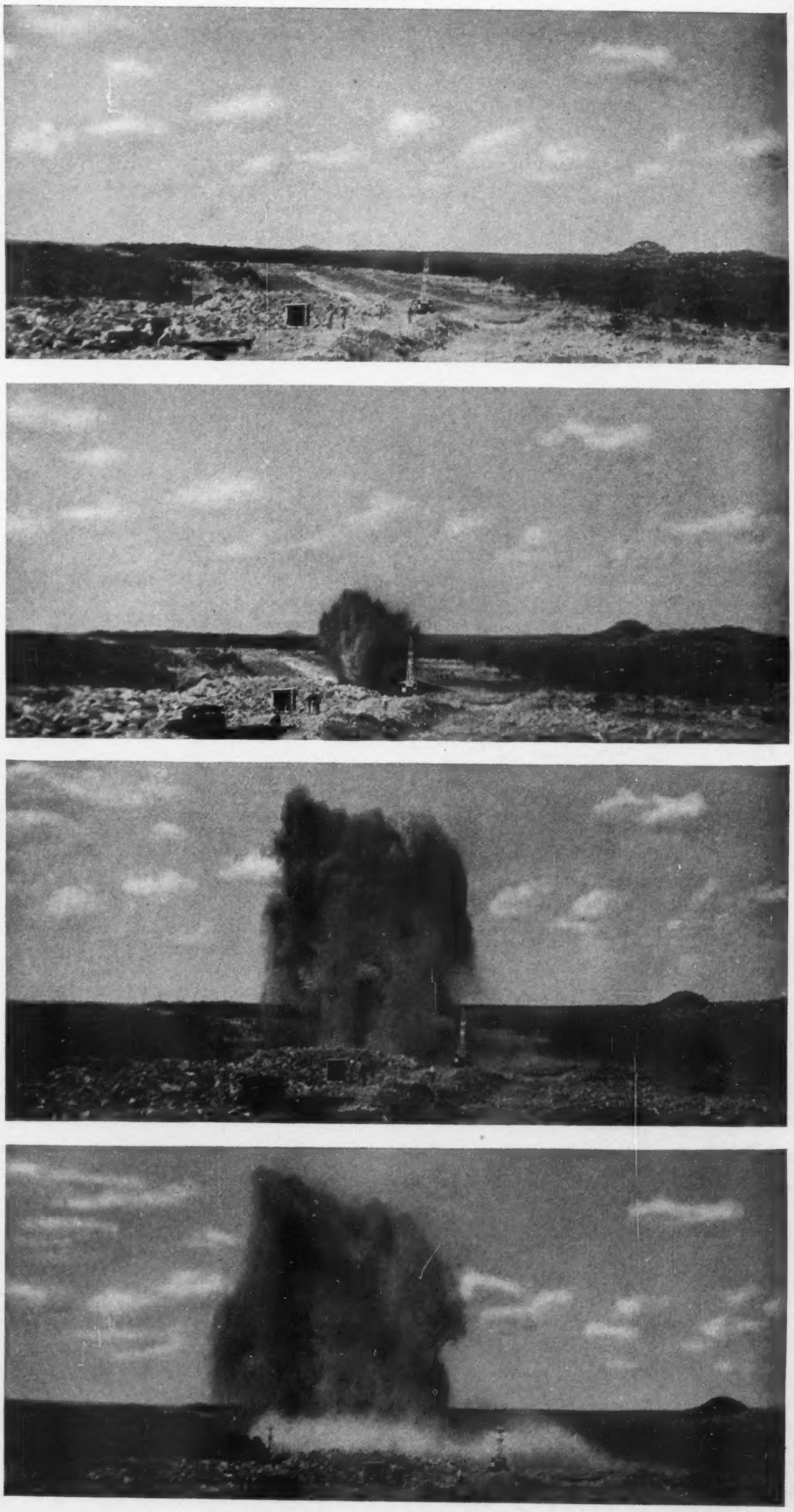
1,000,000 acre feet. The dam has accordingly been designed to impound that volume of water. At normal full-pool level, the reservoir will be about 26 miles long and 6 miles wide and will have a surface area of 23,000 acres.

Buchanan Dam will be really a series of dams, somewhat L-shaped in plan and measuring 11,200 feet from end to end. The main structure, which will span the river channel, is to be a multiple-arch dam consisting of 29 reinforced-concrete arches having a span of 70 feet from center to center of their supporting buttresses. The over-all length of this section will be 2,030 feet and the maximum height 160 feet above the foundation and 140 feet above the stream bed. Flanking this section on the south, which is the shorter leg of the L, will be 650 feet of gravity bulkhead section, S-shaped in plan. Adjoining this is to be another multiple-arch section consisting of 23 bays of 35-foot-span arches. A short gravity section will connect its south end with the adjacent hillside abutment.

At the north end of the main channel section there will be a main spillway section controlled by seven 40x25-foot Taintor gates, and, adjoining it, a non-overflow gravity section approximately 1,000 feet long that will be tied into the south side of a granite-knoll abutment. From the north side of this granite knoll, a non-overflow gravity section will extend approximately 900 feet northward to an auxiliary spillway section controlled by fourteen 33x15-foot Taintor gates. Then will follow a non-overflow gravity section of approximately 1,050 feet, a second auxiliary spillway section controlled by sixteen 33x15-foot Taintor gates, and a non-overflow section of approximately 1,250 feet that will reach to the north abutment. A rolled fill section approximately 1,800 feet long will close a small draw north of the gravity-section abutment. The rolled fill section is under construction by Brown & Root under a contract calling for $38,507 which was awarded by the Bureau of Reclamation during the period that it was in charge of the operations. The total spillway capacity of the structure will be approximately 500,000 second feet.

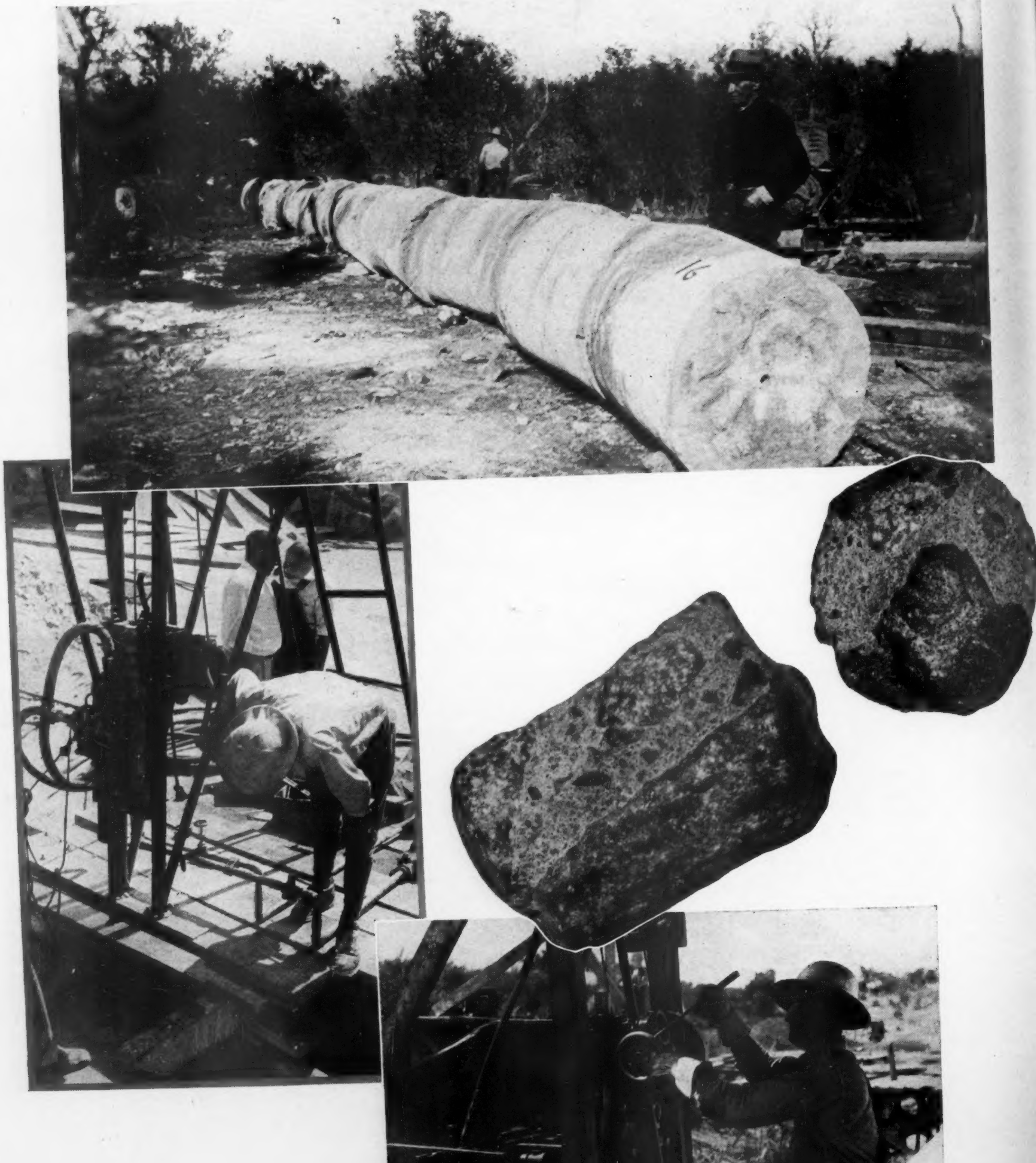
Buchanan Dam is of unusual design, in that it is to be made up of three separate and distinct types of construction: the multiple-arch, the gravity, and the rolled-fill sections. Moreover, different sizes of arches will be used in the two multiple-arch sections. This structure will be one of only four multiple-arch dams of any size thus far built in the United States. The Bureau of Reclamation now has under construction on the Verde River in Arizona the Bartlett Dam, which is also of the multiple-arch type.

Foundation conditions and the height of dam required at the Buchanan location were especially favorable to the multiple-arch design, which offered a saving in first cost over any other suitable type of construction. The barrel of each 70-foot arch



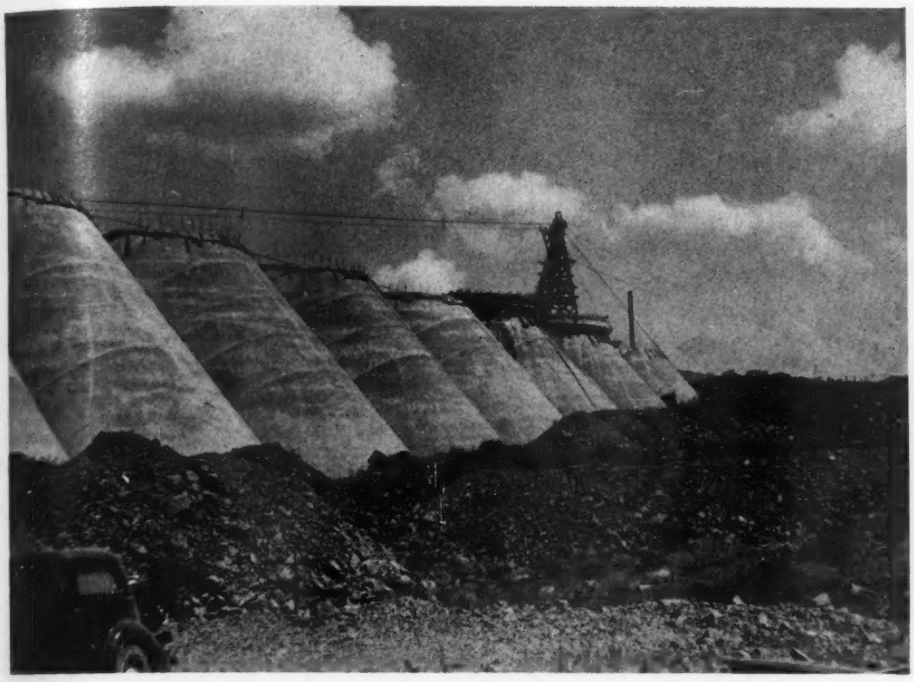
PICTORIAL STORY OF A BLAST

This sequence of views shows the results of setting off simultaneously three hundred 12-foot holes in a foundation trench being excavated for the gravity section at the south end of the dam. The pictures were taken, at intervals of a second or two, with a high-speed miniature camera. Holes in this trench are drilled with S-49 "Jackhamers" and "Jackbits."



EXPLORATORY AND GROUTING OPERATIONS

The extraction of large-diameter cores from the basement rock on which large dams will rest is becoming more and more the standard practice. The top picture shows assembled sections of a 36-inch core taken at the Buchanan Dam site with a WS "Calyx" drill. Grout holes are also drilled with smaller "Calyx" machines, one of which is illustrated at the bottom. Slanting across the page are a side view and an end view of a 2-inch core that shows the contact between the concrete (the lighter material) and one of the granite abutments. Recently grout holes as deep as 80 feet have also been successfully drilled with the wagon-mounted X-71 drifter drill shown at the left.



MAIN ARCH SECTION TAKES FORM

A view from upstream of a section of the 70-foot-span arches. This type of construction has been used to only a limited extent in the United States, but the conditions here were such as to call for its employment in preference to other types. A straight gravity type dam would have required a great deal more concrete and consequently increased the cost materially.

varies in thickness from 3 feet 6 inches at the bottom of the lowest section to 2 feet 4 inches at the top. Each supporting buttress varies in thickness from 9 feet at the lowest section to 3 feet at the top. Buttresses will be amply reinforced by counterforts.

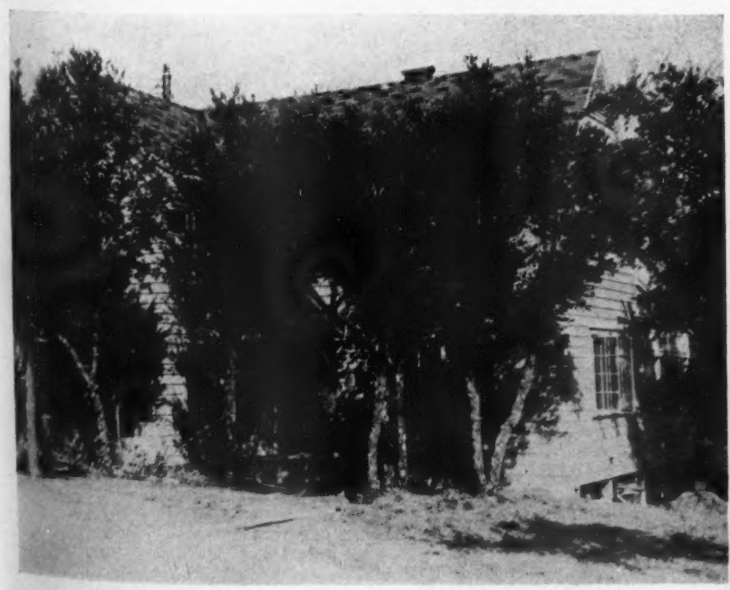
The dam site is in heavily rolling country that is punctuated here and there by features in sharp relief that owe their existence to erosional forces. The underlying rock, which is covered by varying amounts of soil, is granite, with some black schist intrusions. To determine the compactness of the foundation rock, much core drilling was done with the "Explorer" drill at the outset of the current work and, in line with recent practices, large cores were extracted with "Calyx" drills. This work answered the dual purpose of providing geological sections for study and of permitting geologists to descend into the holes to examine the rock in place.

To guard against seepage beneath the dam, the zone immediately upstream from it is being thoroughly grouted. Mr. Alsop decided to investigate the feasibility of drilling 60-foot grout holes with a drifter type drill on a wagon mounting and selected an Ingersoll-Rand X-71 drill for the purpose. Coupled drill rods and "Jackbits" are being used. The results obtained are exceeding the most optimistic expectations, and in recent weeks holes have been put down as deep as 80 feet in the pink granite. Such a depth is, of course, far beyond the rated capacity of the machine. The degree of success attained in drilling such holes depends largely upon the nature of the rock and the skill of the operator.

The main portion of the dam is being built in two sections. The first construction area was inclosed by a cofferdam consisting of two parallel walls of timber sheeting 18 feet apart with the space between them filled with clay. In building up this portion of the dam, three 8x8-foot openings were left in each of three consecutive arches to handle the flow of the river during the construction of the remaining half. A 48-inch gate valve was also installed for the purpose of releasing water for downstream irrigation needs during the filling of the reservoir. Although the generation of power is not contemplated for the present, openings for penstocks are being provided for in the dam. As the structure was originally projected by the power company that initiated it, two 12,500-kva. generating units were to have been installed, and space was to have been provided for a third unit.

Aggregates for making concrete are being manufactured on the site by crushing dolomitic limestone that is quarried nearby. Sand is dredged from the Llano River, a few miles downstream from the construction area, and is transported to the work in railroad cars. One crushing plant was placed in operation during July. The primary reduction is made in a 36x24-inch Allis-Chalmers jaw crusher having a capacity of 1,000 to 1,200 cubic yards in 24 hours. Crushed material is conveyed to a screen and the rejects are run through a secondary crusher. The product of the secondary crusher joins the material that passes the first screen, all is washed, and then classified into four sizes: 3 to 6 inches, 1½ to 3 inches, ¾ to 1½ inches, and less than ¾ inch. The various sizes are stored in bins to await use.

Concrete is being mixed in two central



PERSONNEL AND A HOME

From left to right, the men are Rep. Fritz Englehardt, largely responsible for the dam; R. V. Alsop, in charge of construction; and William Lowitz, drill foreman. The house, occupied by Mr. Alsop, is typical of the attractive, low-cost dwellings erected at the dam site.

plants, one of which contains two 2-cu-yd. units and the other two 1-cu-yd. units. Owing to the extensiveness of the construction area, various methods of placing concrete have been adopted to meet the different conditions that exist. A cable conveyor that carries a 4-cu-yd. bucket is being used to transport the bulk of the material for the main structures. All concrete is being placed with buckets, no spouting or chuting methods being employed.

As can readily be appreciated, it is imperative that high-strength concrete be used for the arch sections of the dam. It has been specified that Class A concrete having a strength of 3,500 pounds per square inch after 28 days be employed for these structures. For the buttresses and for the gravity sections, Class B concrete, having a 2,500-pound strength per square inch after 28 days, will be used.

Comprehensive tests are being conducted of all materials being incorporated in the dam. Tests of concrete have thus far shown very satisfactory results. Tests are being made by the Southwestern Testing Laboratories, under contract, and a representative of that firm is at the dam site at all times. All cement is being supplied by the Republic Portland Cement Company of San Antonio, Texas, the Bureau of Reclamation having previously awarded a contract calling for the delivery of 365,000 barrels for use in the Buchanan and Roy B. Inks structures.

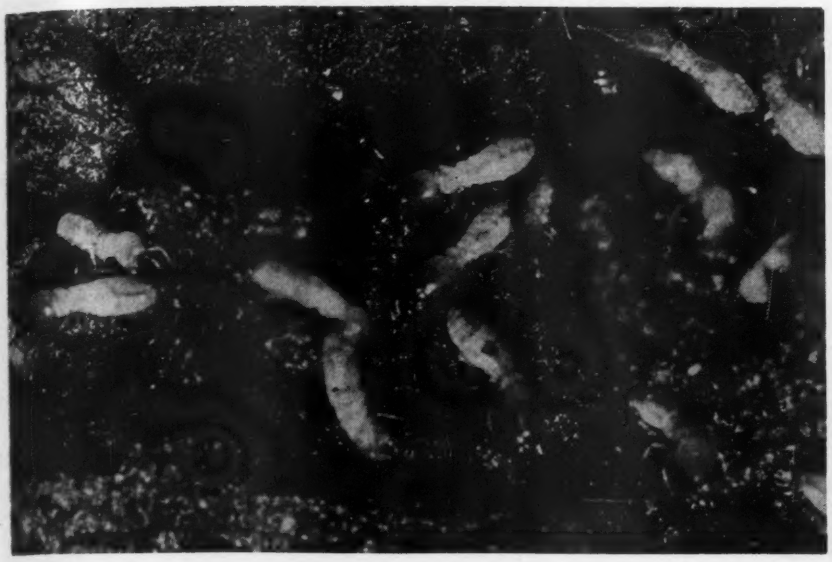
Nearly all the land that will ultimately be flooded has been acquired by the Authority. Prices paid range all the way from \$5 to \$50 an acre, depending upon the value of the various tracts for grazing and agricultural purposes. As would be expected, several small town sites had to be taken over. The acquisition of all the property concerned seems to have been handled with remarkable fairness, skill, and tact. Two cemeteries had to be moved, and some relocation of highways was necessary.

In the beginning of this article, it was mentioned that the rights to the flood waters of the Colorado River were vested in the Authority. The question naturally arose as to what constituted flood waters. Fortunately, the Texas Board of Water Engineers had detailed records of the river's flow at stated periods for the past 12 years. From these data it has been possible to arrive at an equitable decision as to what is normal flow, and the surplus is classed as flood waters.

Buchanan Dam is officially designated as Federal Works Project 380-R.

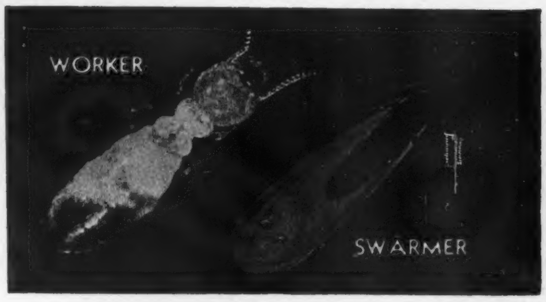
ROCK DRILLS AND COMPRESSORS

As on all large construction jobs, compressed air plays many helpful parts. The center picture shows "Jackhamer" men drilling for an excavation for the south gravity section. At the top is one of the several air-cooled, 2-stage portable compressors, and, at the bottom, one of two Type XCB-2 stationary machines.



Fighting Termites with Compressed Air

John W. Ripley



TERMITES AT WORK

It is rarely possible to photograph termites, for they flee from light. The picture above was taken by means of a flashlight immediately after the colony had been uncovered. At the right are shown a blind, wingless worker and a swarmer. The latter migrate and establish new colonies.

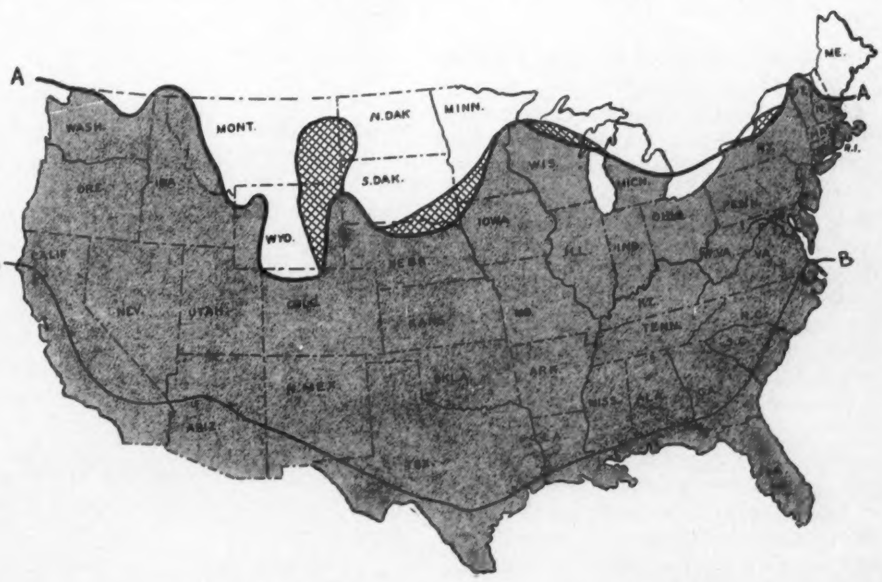
TERMITES are in the headlines. They have literally eaten their way to the front page of practically every newspaper in the land. From obscurity a decade ago, termites (then incorrectly called flying or white ants) have become the most notorious of all insects, mainly because property owners are just now awakening to the fact that nearly 50 per cent of all old structures are, to some extent, infested. Nor is it unusual to hear about new structures, less than a year old, being seriously damaged. Not generally known, however, is the part being played by compressed air in effectively checking the ravages of termites, in permanently insulating structures against further damage, and in assisting the lumber industry to solve a problem that for a time was uncontrollable.

Subterranean termites are hungry little fellows. Their annual feed bill is estimated to be approximately $50,000,000, and it seems to be getting bigger every year, because termites are claiming more new territory annually. While the present situation is serious, it does not have the hopeless aspect that it had ten years ago. About that time those interested in termite control were just learning some bad news: The only recommended treatment of that time—spraying or brushing the infested wood with chemicals—was ineffective in most cases. The penetration of the chemicals used was not nearly deep enough to kill the working colonies. Neither would the spraying of uninfested wood prevent termites from entering it. Far-sighted men in the lumber business then realized that the future of their entire industry might be jeopardized unless termites could be conquered permanently and economically.

Subterranean termites originally lived in forests and fed on stumps and logs. As the forests were cleared, the termites, lacking a suitable habitat, simply moved into town. Burrowing deeply into the ground, one termite colony may construct a maze of tunnels extensive enough to baffle the so-called "expert exterminator." No sooner will he succeed in checking the insects at one point than they will crop out nearby to continue their destruction with a vengeance. The trouble with most of the so-called expert "exterminators" is that they have never learned the introduction to Uncle Moses's formula for catching a rabbit: "Fust off, you gotta be smarter dan de rabbit - - -."

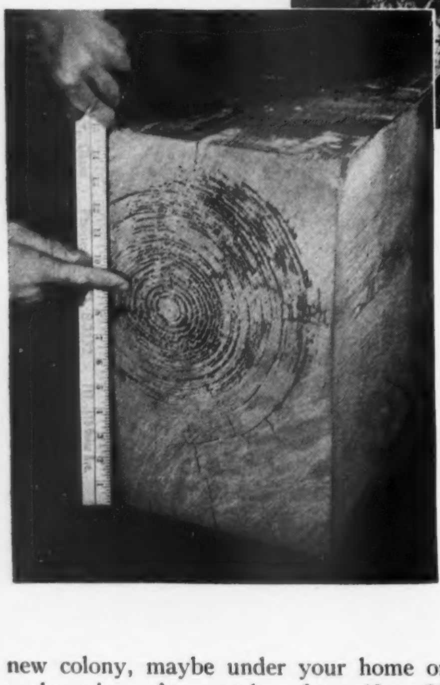
Rarely seen are the wingless, sightless, grayish-white, sterile "worker" termites that make the excavations for the colony. They live underground, eat cellulose (mostly wood cells) and with their moist excrement form the tunnel walls. These workers are the destructive members of the colony. A detail of "soldier" termites guards the blind workers at all times.

The only termite caste that is seen above ground, usually in the spring and fall, is that constituting the winged sexual members that migrate in a swarm from their parent colony, later to lose their wings and start new colonies. Each pair that survives the migration becomes king and queen of a



THE INCREASING TERMITE TERRITORY

A few years ago termites confined their activities to the South. But recently they have been sweeping northward and have now been reported in every state in the Union. The line A-A indicates the northern limit of subterranean termites as it existed at the end of 1935. The cross-hatched areas are territory that has been invaded thus far in 1936. The line B-B represents the northern limit of distribution of nonsubterranean or dry-wood termites.



TRAILS OF TERMITE DESTRUCTION

Termites enter buildings from the ground, seeking the lowest wooden members and eating their way upward, always within the timbers and out of sight. Oftentimes there is no sign of their presence until much damage has been done. In the case of the picture at the right, plaster and flooring hid them until they had practically wrecked the corner of the structure. At the left, above, is a 12x12-inch pine sill as it appeared when it was removed from an industrial building in Knoxville, Tenn. The lower view shows the damage done to the interior of a heavy timber. Note that there is no evidence of destruction on the outside surfaces. Termite damage in this country is estimated at $50,000,000 annually, or one-fifth the toll taken by fire.

new colony, maybe under your home or under mine. A queen lays from 40 to 80 eggs every day. The room that shelters the royal pair is usually far below the earth's surface, and the insects are seldom located.

What will termites attack? Anything that has cellulose in it. They will work over steel, glass, stone, brick, concrete—in fact over any building material. Many problems therefore arise in connection with the protection from termites of stored materials as well as of the buildings themselves.

Six years ago termites had been discovered in all except our northern tier of states. Today no state is uninfested. Canada is beginning to report their presence. Several reasons have been advanced for the year-by-year increase of termite damage. Modern basement heating, now common in even rural homes, invites termite colonies. Such conditions are suitable for year-round activity—and damage, whereas before the era of central heating the termites' activities were confined to the summer months. As mentioned before, the migration from the forests to homes must be considered of some importance in reckoning the ever-increasing damage.

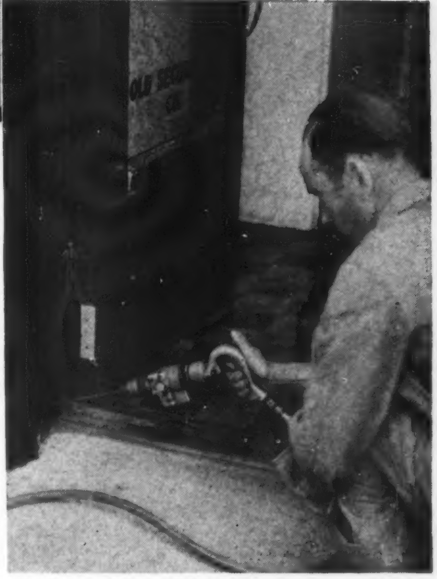
Has the present termite-damage situation been overemphasized? Possibly so in certain quarters where so-called "exterminators" have circulated scare stories in order to stimulate a demand for their services. However, the fact remains that in one national survey of more than 500,000 buildings, more than 50 per cent were found to be infested to some degree. In St. Louis a check of 3,000 buildings showed 2,100 of them to be harboring termites, and more than 50 per cent of these required costly structural replacements.

The seriousness of termite damage has recently been acknowledged by the "America Fore" insurance and indemnity group, one of the leading insurance organizations in the United States. In a bulletin which that group has published on the subject of termites in this country, appear the following statements regarding the "sound value" of frame structures infested with those insects:

> . . . "And this one point of 'sound value' is of importance to us. Unusual stresses and strains on termite-weakened wood structures, whether brought about by earthquakes or windstorms or floods, may result in much greater damage than that which may be expected on structures not so weakened.
>
> . . . "Reduced below the original factor of safety. Herein lies our interest as insurance men. Unusual—or even normal stresses and weights—on weakened floor beams, flooring, ramps, and stairways—may result in claims under public liability coverages or under employers' liability coverages. There is no intention in this to exaggerate probabilities. Rather it is intended to emphasize possibilities."

But to get back to compressed air and how it saved the day and, possibly, the lumber industry. Hardwood flooring came into great popularity immediately after the World War. By the year 1920, E. L. Bruce Company, Memphis, Tenn., had risen to the position it still holds: the largest manufacturer of hardwood flooring in the world. At that time, sixteen years ago, the Bruce firm, together with other flooring manufacturers, began to receive letters from customers saying, "Bugs of some sort are in your flooring," or "The flooring you recently furnished us has already rotted out." The many complaints led to investigations which proved that the so-called rot damage could often be charged to termites. Further investigation proved that the termites could not possibly have been shipped in the flooring from the mills: that their activity, therefore, started after the flooring was laid.

The findings of the Bruce investigators were reprinted in trade journals of the lumber industry. Immediately there followed



CURBING TERMITE RAVAGES

The most effective known substance for combating termites is Terminix, a chemical compound patented by E. L. Bruce Company, largest manufacturer of hardwood flooring. Licensees in 34 states apply Terminix with air pressure. Air-operated tools are employed to make the openings in concrete, brick, and wood through which the toxic solution is introduced. The workman at the left is using a chipping hammer to gain access to a foundation wall. A "multi-vane" drill is seen at the right penetrating woodwork. The center picture shows a workman driving a nozzle into a hole in a joist preparatory to injecting the inoculating Terminix fluid under 125 pounds air pressure.

a flood of inquiries from lumber dealers, contractors, architects, and other floor manufacturers: "What can we do about it?" Government entomologists were consulted and a carbolic-creosote spray was recommended as being effective. Carefully watching lumber that had been so treated and exposed to termites, the Bruce Company found, after two years of testing, that all spray treatments were of questionable value, some absolutely worthless.

In 1927 the Bruce Research Laboratories were established. Their program was broad: to study wood, its uses and methods of improvement. Their first task was to attempt to solve the termite problem. While scientists had previously studied the habits of termites, there had been little concentrated scientific effort by any responsible concern to develop a chemical means of control. The logical steps in the research were:

(1) Study of the life history of termites.

(2) Study of how termites infest a building.

(3) Study of and experimentation with all chemicals previously used in attempts to control termites.

(4) Study of great numbers of chemical compounds and combinations which would most economically control termites and yet be acceptable for use in buildings.

(5) Study of relatively permanent toxic substances which could be included in solutions to give more than temporary protection.

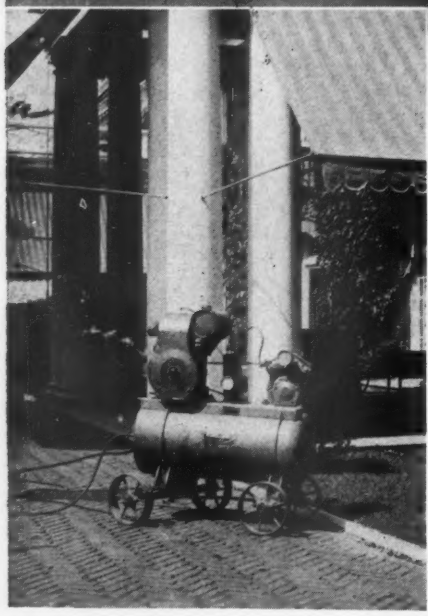
(6) Study of methods for best applying chemical in order to accomplish prompt killing as well as substantially permanent protection.

(7) Development of the original Terminix formula and experimental treating of termite-infested structures with it.

At that time railroads and telegraph, telephone, and power companies had already developed several excellent methods of treating poles, ties, and structural timbers that came in direct contact with earth, but none of these could be applied to buildings already constructed. Most of the methods included complete immersion of timbers in creosote compounds under air pressure and often in the presence of heat. The odor alone of such chemicals, offensive and lasting, precluded their use in residences. Nor was it possible bodily to pick up a termite-infested building and "dunk" it in the awful-smelling mixture. However, the Bruce experts recognized the fact that chemicals must be applied under pressure: mere spraying or even soaking would not be effective. With that in mind the present Terminix chemical and method of application were developed after years of tedious research and testing.

Terminix insulation work in reality begins where methods of "eradication" leave off. Recognizing the difficulties involved in assuring lasting protection, the Terminix formula, the equipment designed for its use, and the training of Terminix operators all aim at impregnation and insulation. These objectives are attained by means of three lines of defense laid down against further termite attack. First, actual killing and soil inoculation by Terminix treatment at the first line of attack. Second, pressure-treating and blocking off of all contact points on foundation walls and supports. Third, and most important of all, high-pressure injection and impregnation of all understructure wood members at their bearing points on all supporting structures. The liquid Terminix evaporates a few hours after pressure application, but a crystallized permanent toxicant, poisonous to termites, remains wherever the liquid has penetrated. This toxic film is the true barrier to termites—they cannot eat through it. Thus, the principle of Terminix insulation is based on protection of the structure itself, rendering it immune to further termite attacks. The results of Terminix insulation are:

1—Chemically placing a shield between the structure and the ground from which these attacks originate.



TERMITE-ERADICATION EQUIPMENT

Approximately 25,000 structures have been given the Terminix treatment. The average cost for a residence is $150: for larger buildings it frequently reaches $5,000. Above is shown equipment in front of a school building in Wichita, Kans., that was infested despite its fireproof construction. An Ingersoll-Rand portable compressor is mounted on the left-hand truck. The lower picture is of a gasoline-engine-driven Type 30 compressor that is used by the Terminix Insulation Company of New York City for residential work.

2—Preventing those termites within the structure from recontacting the ground, resulting in their death by cutting off their supply of moisture and contacts with their nests, both of which are indispensable to subterranean termites.

3—Preventing those termites in the ground from going up to attack the structure for food (cellulose).

4—Rendering completely toxic the entire understructure of the building. Termites remaining in the ground are thus held away from the superstructure. They may be driven away to other feeding places, be killed by attempting to penetrate the toxic shield or by eating the poisoned food supply, or may die of starvation.

At present 53 companies in 34 states are licensed to apply Terminix. Each firm is required to maintain several portable air compressors (usually mounted on auto trucks), a complete set of air-driven wood drills and rock drills, and pressure treating nozzles. Obviously, a Terminix licensee cannot be a fly-by-night "exterminator." Many of the Terminix operators have had previous connection with the construction industry as contractors, architects, or lumber dealers. A knowledge of construction methods is essential to their work.

In making inspections for the purpose of locating termite damage, all Terminix representatives follow a prescribed routine which includes preparing a written report concerning the condition of: (1) Foundation walls (termites often enter by way of masonry cracks—their mud tunnels are frequently noted on the inside of the walls); (2) Any wooden supports such as porch piers; (3) All sills, joists, girders and headers; (4) Flooring, sub-flooring and stairs. Armed with only a sharp ice pick and a flashlight, a trained inspector will quickly locate termite infestation, if it exists, by probing for damaged timbers.

Wooden porch supports are most inviting to termites. Having dined well under the porch floor—enough to cause a decided sag on one or more corners, the hungry horde invariably moves into the house through the sills. There they will dine on joists and studding for a while. Finally they may work up into the piano or, if the colony favors art to music, they may take a liking to a nice framed picture, devouring it, frame and all.

The principle of impregnating timbers with Terminix is that of injecting enough Terminix fluid at 125 pounds pressure into the cells of the wood to discourage further termite attacks. The Bruce authorities do not claim that the fluid will penetrate every cell and fiber: such results can be obtained only with hot chemicals in tanks and under extreme pressure. The degree of penetration, of course, depends upon the kind of wood, its age, cellular construction and moisture content. The holes are bored at sufficient intervals to assure overlapping of the chemical injections.

In addition to the important part that compressed air plays in impregnating structural lumber with chemicals, several air-operated tools are regularly employed for other phases of the insulation. To impregnate the soil around and under buildings, a long injecting nozzle is often used, particularly in the case of nonporous clay or hard-pan soil. In such cases the fluid is shot into the earth under air pressure instead of flooding the surface. Because compressed air is always available, most Terminix insulators use air drills and hammers in preference to other types. There is much drilling to be done on every job, both in concrete and in wood, and it is important that the drillers keep ahead of the injectors.

Each Terminix insulation job is reinspected every six months for five years—the term of the guaranty (which is backed by an insurance policy).

Among the hundreds of different industries that have contracted for Terminix service are railroads, stockyards, packing plants, oil refineries, and tobacco manufacturers. Contrasted with the time a few years back when the average person would have pooh-poohed the idea of "those little white bugs" wrecking a building, tight-fisted business executives are now spending hundreds of thousands of dollars annually in termite insulation. Most of them declare it is cheap insurance.

Deaeration of Water Checks Corrosion in Pipe Line

IN THE September, 1935, issue of this magazine we published a detailed account of the development of the Grande Ecaille sulphur domes by the Freeport Sulphur Company. Mining there as elsewhere in the Gulf Coast region of the United States is done by the Frasch process—that is, by pumping hot water down into the rock formation and thus melting the contained mineral, which is then brought to the surface by air lift. As can be appreciated, the operations require great quantities of fresh water not only for mining but also for raising steam to heat the mine water, to actuate pumps, and for other services. As the water in the vicinity of Grande Ecaille is salty, it was necessary to go somewhat far afield to assure a satisfactory supply. A 70,000,000-gallon reservoir and a pumping station were built on the Mississippi River, whence the water is delivered by means of a pipe line 9 miles long. Local conditions necessitated the use of steel piping for this line, and as it was welded it could not be given a protective coating inside against rust. Trouble was soon experienced with it; and the story we have to tell is how it has been overcome.

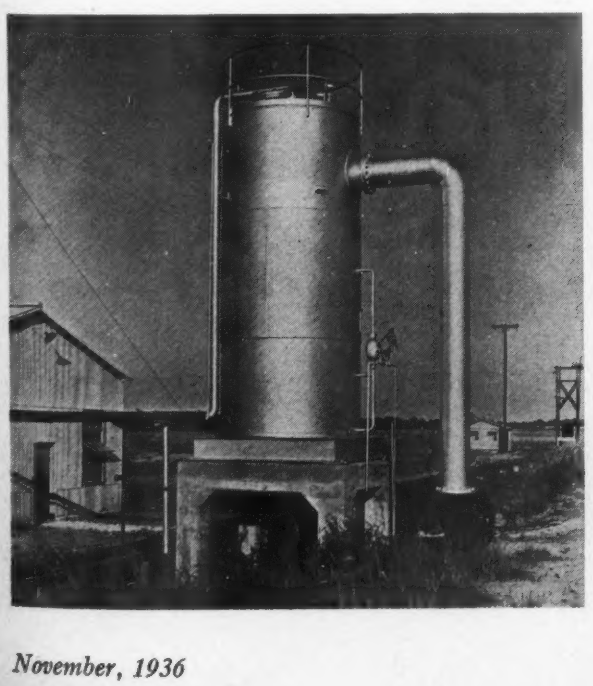
Originally the line had a carrying capacity of 4,090,000 gallons daily. Within a little more than four months the volume had dropped to 3,170,000 gallons, representing a decrease of 920,000 gallons or 22 per cent. This was a vital matter, as it meant a reduction in plant operations and the possible destruction of the line within a relatively short time. Investigation revealed that corrosion was primarily responsible. Various measures were promptly taken in an effort to check it, but without much success. These included pumping a solution of hydrochloric acid through the mains and treating the water with sodium silicate, chlorine, and sodium sulphite, respectively.

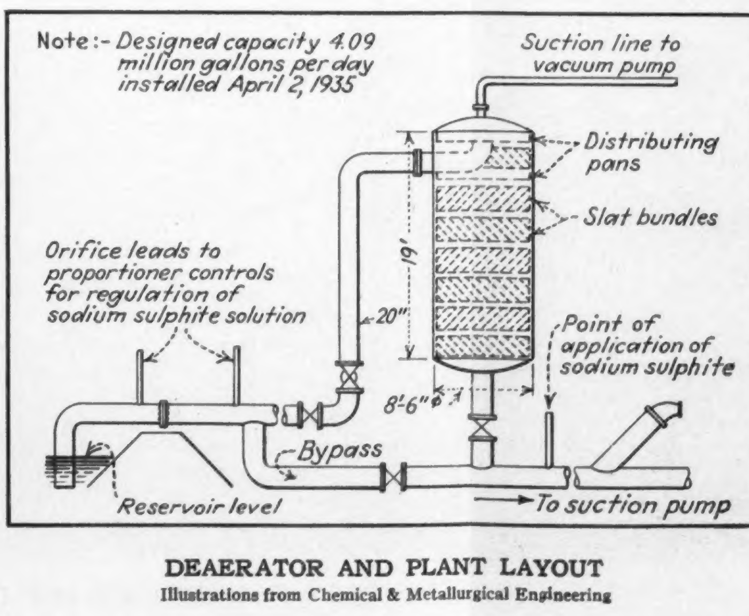
At this juncture Sheppard T. Powell, a consulting chemical engineer of Baltimore, Md., was called in to help solve the problem. It was believed that deaeration of the water would probably be the most effective remedy; but how best to remove the dissolved oxygen, that was the question. Mechanical methods were deemed impracticable because of the volume of the water to be handled, and the use of chemicals was considered too expensive. Although deaeration of cold water under a vacuum had been tried on only a small scale in the United States, it was known that large quantities had been treated that way in Coolgardie, Australia, for the purpose of preventing further corrosion inside of a pipe line 350 miles long and 30 inches in diameter. The vacuum deaerator erected there handled 6,000,000 gallons a day and did its work effectually.

Laboratory tests by the Freeport Sulphur Company confirmed these facts. The experimental plant that was built had a capacity of 100 gallons a minute, and when operating under a vacuum equivalent to 28.5 inches of mercury effected the removal of 95 per cent of the dissolved oxygen. When the 4-inch discharge pipe was inspected after three months of service it was found that no rust tubercles had developed. The remaining 5 per cent of oxygen in the effluent was easily taken care of by sodium sulphite at a cost of $1 per 1,000,000 gallons. Its use was decided upon when it was learned that pumping costs grew progressively and rapidly higher as the vacuum increased beyond the aforementioned point.

The large-scale plant which is now in service was designed accordingly. By means of vacuum pumps the water is drawn from the reservoir into the top of a cylindrical tower or tank 19 feet high. There it flows first through two perforated distributing pans and then successively over a series of wooden slat bundles, the deaerated effluent passing directly into the suction of three 10x8-inch, 2-stage centrifugal pumps. Immediately after reaching the suction line the sodium sulphite is added by a Cochrane chemical proportioner which is controlled by an orifice plate interposed in the line. The system is arranged so that in the event of an emergency the water can be by-passed and treated with sodium sulphite only.

The vacuum deaerator represents an investment, including engineering, of approximately $12,000. It was put in use in April of 1935, and in reporting on it after the expiration of a year, Mr. Powell and Homer S. Burns, chief engineer of the Freeport Sulphur Company, said: "Since the apparatus has been in operation the total decrease in the carrying capacity of the pipe line has been only 36,000 gallons per day over a period of eight months. Recent examination at several points has indicated that the tuberculation on the surface of the pipe has been almost completely inhibited. It is probable that the carrying-capacity loss of the pipe line which now occurs is the result in the change in coefficient of friction traceable to surfaces roughened by corrosion previous to the solution of the problem. There is some indication, also, that organic slimes resulting from the presence of iron-bearing bacteria are partially responsible for existing friction losses. Measurements show that equilibrium has been practically reached and that further corrosion losses will be negligible. Results of the operation of this plant for a year have demonstrated it to be a practical method of inhibiting corrosion of uncoated steel pipe lines, and that such corrosion control is definitely within the range of practical application even for large volumes of cold water."



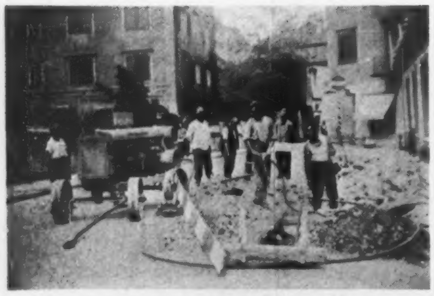


DEAERATOR AND PLANT LAYOUT
Illustrations from Chemical & Metallurgical Engineering

THE MOST FAMOUS SKYLINE IN THE WORLD: THE TOWERS OF MANHATTAN ISLAND

ATTAN ISLAND AS THEY APPEAR FROM THE NEW JERSEY SIDE OF THE HUDSON RIVER.

American Equipment Aids Swiss Contractors



IN RORSCHACH

An attractive Swiss town situated on Lake Constance, source of the Rhine River. The large view shows its *Hafenplatz* or harbor approach. The white building at the far end is the warehouse that is mentioned in the text. A Type 20 portable compressor and American-made tools have hastened the completion of numerous local construction projects. The small pictures show the excavating of sections of a 2-mile trench for telephone and telegraph cables.

MUCH is written concerning the accomplishments of compressed-air equipment on large construction projects throughout the world; but comparatively little gets into print regarding the part it plays in carrying out the smaller jobs that are continually being done the globe over. While the latter may lack the spectacularity that mere bigness imparts, their aggregate importance far exceeds that of the huge undertakings.

From Rorschach, Switzerland, on Lake Constance, there comes from P. Bagattini, a general contractor, a voluntary tribute to the effectiveness of American-made portable compressors and air-driven tools that was prompted by their performances on miscellaneous work that the firm has carried out in that section.

A gasoline-engine-driven, portable unit was purchased several years ago when the firm had a contract to install the towers for supporting the overhead electric power cables for the Heidener Cogwheel Railway. This line extends from Rorschach a distance of 12½ miles up a rocky mountain valley. The towers were placed in pairs—one on either side of the track, and at each location it was necessary to excavate a 6½-foot hole in solid rock. Thanks to the compressor and the rock drills operated by it, no trouble was experienced in doing the work with economy and dispatch. The success of the equipment was such that various competitors of P. Bagattini sought its use when it was available. One of them kept the compressor nearly a year while engaged in building state roads and public squares.

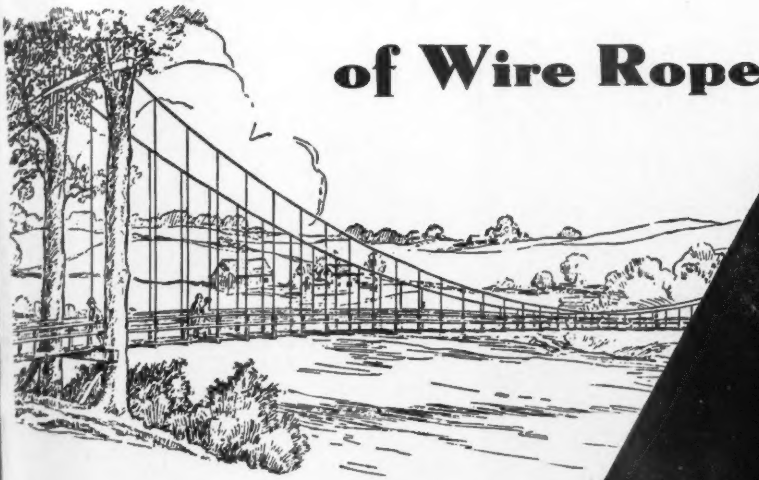
Rorschach now boasts a great warehouse at the head of its *Hafenplatz* or harbor approach. That structure was erected by P. Bagattini on the site of a previous building. The razing of the older structure was accomplished by the aid of the same portable compressor and its complement of air-driven tools. The saving in the time of demolition over and above that estimated was such that the new building was ready a month before the scheduled date. Similar speedy progress was made in the construction of a part of the Dornier Airplane Works, where the famous Do-X ships were built. The outfit was next put to good service in connection with the erection of a storehouse and factory for the Conservenfabrik (cannery) Rorschach.

Last year Bagattini excavated a 2-mile trench from 40 to 60 inches deep for the installation of telephone and telegraph cables. Although concrete, asphalt, and rock had to be broken, the job was completed in two weeks. This record would have been impossible by manual methods, unless a large force of men had been employed. Despite its long and severe service, the compressor has never developed any trouble and is still in good operating condition.

It is generally known that the incessant pounding to which a rock drill is subjected necessitates the employment of high-grade steel in its construction. Nevertheless, probably few persons realize the care that American manufacturers exercise in this matter of selecting materials, unless they have had somewhat extensive experience with such tools. An incident that happened a year or two ago served to impress this point upon the minds of the Swiss contractors. A broken bolt had put a drill out of commission and, rather than await the shipment of a new part, a locksmith of Rorschach was called into consultation. With the best of intentions, he gave assurances that he could fashion a new bolt that would meet the needs, as he had No. I Swedish steel in stock. The new part was made and installed, but it broke in less than a minute. Whereupon a telephone call was made to the manufacturer's representative for a standard part of selected steel and properly heat-treated. This time the repairs proved to be of a more permanent character.

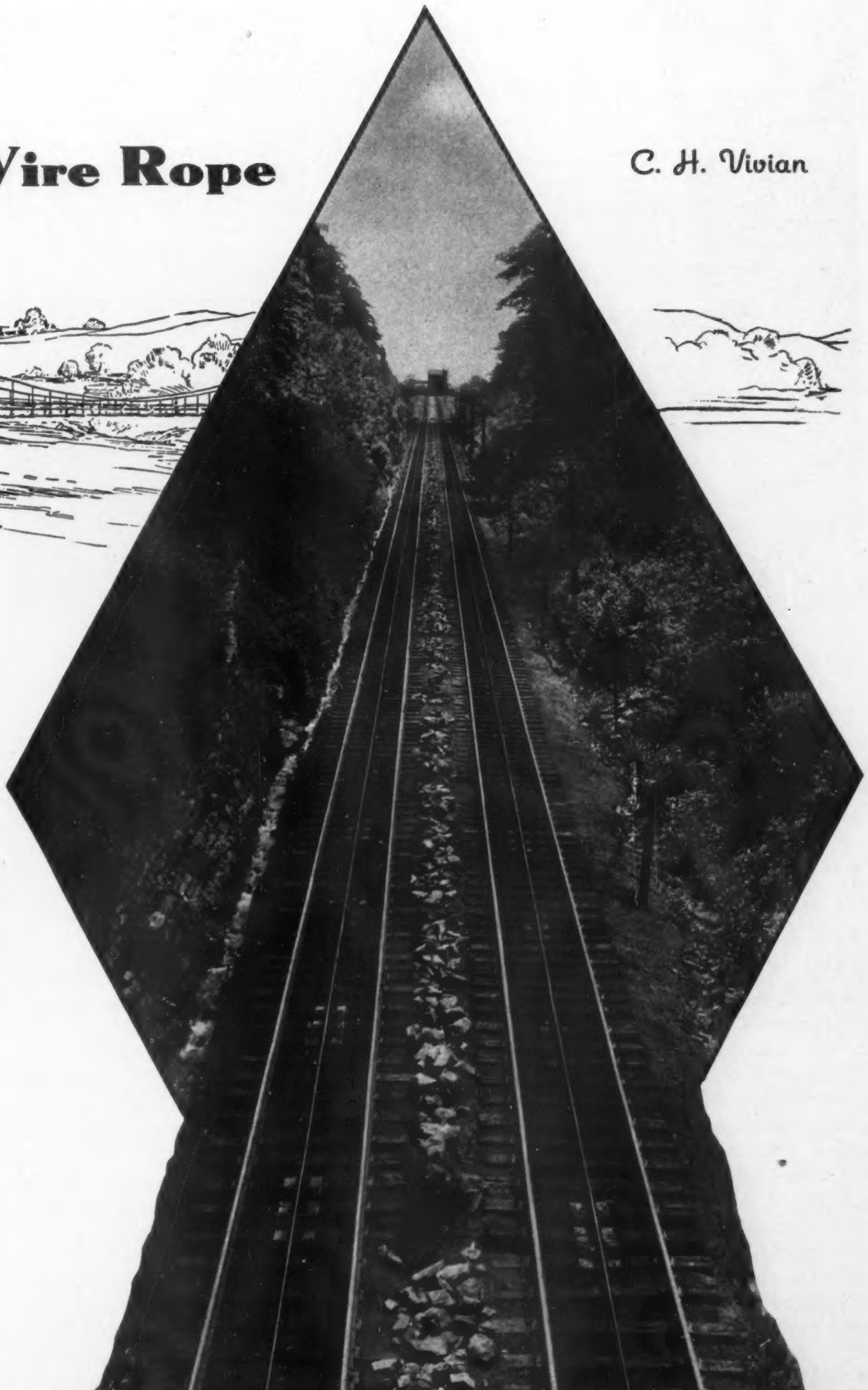
The Genealogy of Wire Rope

C. H. Vivian



FIRST SUSPENSION BRIDGE

This structure, which spanned the Schuylkill River near Philadelphia, was erected in 1816 and was the first ever to be suspended from wires. It had a length of 410 feet and a walkway 18 inches wide. A one-cent toll was charged for crossing it.

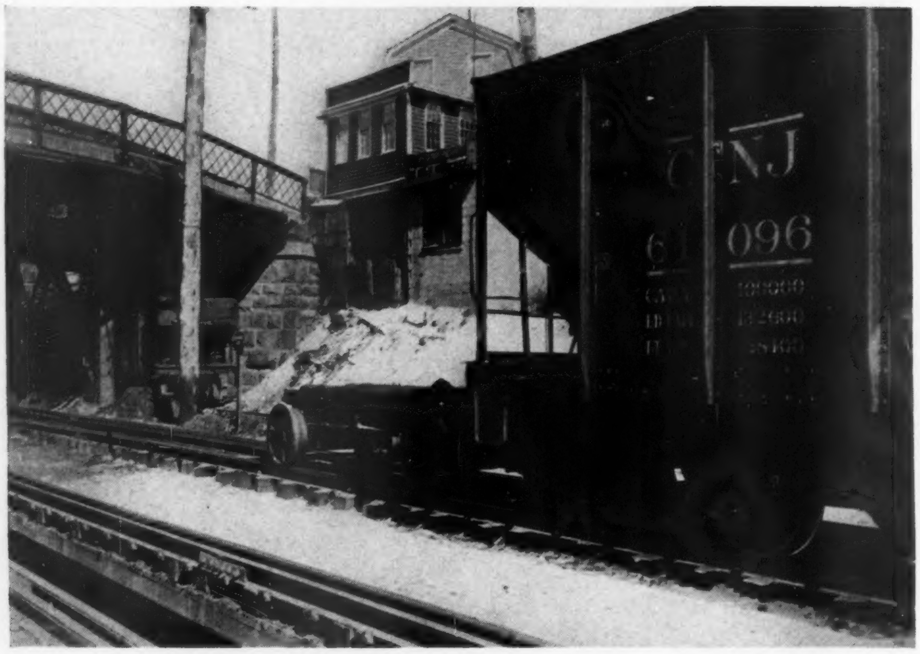


THE ASHLEY PLANE

This is the uppermost in the series of three inclines over which cars of coal are elevated 1,013.75 feet in 2.47 miles by the Central Railroad of New Jersey. This section is 3,700 feet long, and has a grade of 9.28 per cent. Six cars are hauled at a time. The 2½-inch wire rope shown in the picture is attached at its lower end to a 7-ton steel truck or "barney," which is pulled up the slope and which pushes the train in front of it. While one string of cars is ascending, the barney on the adjacent track is descending. At the top of each plane is a boiler plant and a 1,200-hp. vertical steam engine of 40-inch cylinder diameter and 48-inch stroke. The speed of hoisting ranges from 12 to 30 miles per hour, and 35 cars per hour can be conveniently handled.

OFFHAND there would seem to be little indication of relationship between wire rope and anthracite coal, but actually they have been more or less intimately connected throughout the 100 years that both have been in use in the United States. In fact, anthracite owes its start as an industrial fuel to a pioneer wire factory near Philadelphia. As though to pay the debt thus created, the coal producers soon afterward indirectly brought about a demand for wire rope that gave makers of it their first prosperity. Since those early days, both industries have forged ahead, with wire rope continuing to draw a substantial share of its business from the anthracite-producing regions. It is significant to note that two of the present leading manufacturers of wire rope that launched their enterprises a century ago are still carrying on under the names of their founders. They are the Hazard Wire Rope Company of Wilkes-Barre, Pa., a unit of the American Chain Company, and John A. Roebling's Sons Company, of Trenton, N. J.

Anthracite is nowadays so generally recognized as a valuable and effective fuel that it is difficult to realize that people once scoffed at it and called it "black stones," "stone coal," and similar derisive terms. However, unbelievable as it may seem, anthracite had a hard time proving its worth. Tradition has it that a few Indians living near Nazareth, Pa., knew as early as 1750 or 1755 that this coal would burn. There is also evidence that some white men suspected its value in 1763, but the first known reference to it in Pennsylvania records bears the date 1768, and appeared in the original draft of the survey of Sunbury Manor, near Wilkes-Barre.



HOW THE BARNEY OPERATES

Here is shown one of the Ashley Plane barneys in position behind a coal car. The wire rope connected to the barney passes beneath the car and on up the slope to the hoisting plant, where it is wound three times around a drum 22 feet in diameter. A tail rope attached to the rear of the barney extends to the foot of the plane, where it passes around a large bull wheel and back up the adjacent track to the second barney. The bull wheel is counterbalanced by weights to keep the tail rope taut and thus take up slack in the main cables. Each wheel of the barney has its own axle, which slides in a sleeve, making the car adjustable to various track gauges. When it descends to the foot of the slope, the cars it is to elevate are already on the track. To get behind these, the barney descends on gradually narrowing rails into a pit beneath the cars. After moving to the rear of the cars, it is drawn out of the pit on similar rails. Upon reaching grade, it passes on to the standard-gauge track.

Obadiah Gore, a Wilkes-Barre blacksmith, is known to have burned anthracite in his forge in 1769, and other blacksmiths and gunsmiths in the coal-producing areas of Pennsylvania became regular users of it, but it required 50 years to gain its acceptance for industrial and domestic purposes. This is understandable if it is considered that there were vast supplies of wood to be had close at hand, that there were virtually no industries to use the fuel, and that there were practically no transportation facilities available. The primary reason for the delay in its adoption was, however, the failure to discover how to ignite it. In forges there was a forced draft to assist combustion, but when people sought to kindle an ordinary fire, it refused to burn readily. Whereupon they poked it and stirred it, which only made matters worse. Repeated unsuccessful efforts to burn it brought disgust and a deep-seated conviction that this new "stone coal" was worthless for general purposes. Moreover, persons that sought to sell it were looked upon with suspicion.

Judge Jesse Fell of Wilkes-Barre was perhaps the first man to burn anthracite successfully in a grate, and that momentous event did not transpire until February 11, 1808, or 40 years after Obadiah Gore used it in his forge. Judge Fell had been employing anthracite in his nail factory for twenty years previously and believed in its possibilities as a domestic fuel. It was considered the sheerest sort of folly even to attempt to burn it, however, and to save himself from being laughed at, Judge Fell deferred his experiment until late at night when curious eyes were closed in sleep. He then built up a jamb of bricks in his fireplace and placed upon it a grate, having a horizontal member consisting of five iron bars joined to side pieces, and a similar, vertical grill at the front to hold the wood and coal in place. After igniting a bed of hard wood, he covered it with coal and went to bed. When he awakened early the next morning, the fire was glowing merrily.

It was not until 1800 that the first effort was made to introduce anthracite to the world beyond the confines of the section of Pennsylvania where it was mined. In that year William Morris, of Pottsville, took a wagonload of it to Philadelphia, but was unable to sell it. In 1812, Col. George Shoemaker, also of Pottsville, hauled nine wagonloads of it to Philadelphia, at a cost of $28 a ton, and sought buyers for it. Those that examined it pronounced it stone and resolved not to be swindled. Eventually, Colonel Shoemaker sold two loads, but was obliged to give away the other seven and to flee to escape arrest.

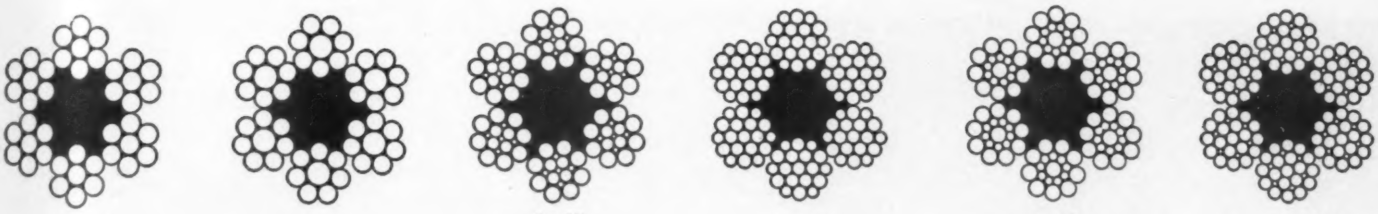
It happened that one of the two loads was bought by White & Hazard, a firm of wiremakers at Falls of Schuylkill. The partners in this business were Capt. Josiah White and Erskine Hazard. The former was an engineer of ability and the latter was even then of the sixth generation of his family in America. His father, Ebenezer Hazard, was the first postmaster of New York, in 1775, and postmaster general of the United States from 1783 to 1789. Erskine Hazard, the son, was educated at Princeton University and wrote numerous essays on currency, banking, and other topics. Being of an inventive turn of mind, he applied himself to mechanical things, and out of these interests grew the association with Captain White. Their regular business was the production of wire and nails, but during the War of 1812 they also cast cannon balls.

Initial efforts to burn the wagonload of anthracite in their furnace were without success and, after working all night, it is recorded that "the hands shut the furnace door and left the mill in despair." Fortunately, one of them forgot his jacket and, upon returning for it half an hour later, noticed that the furnace door was red hot. Opening the door, he found the interior at a glowing white heat. The old account of the incident states that "the other hands were summoned and four separate parcels of iron heated from the same fire and rolled before it required renewing." Here was the discovery of an important fact—that all that was necessary to burn anthracite was to close the furnace and let it alone.

This, then, was the good turn that the wire industry did for the new fuel. Largely as a result of it, anthracite came into favor as an industrial fuel and the demand for it began to grow. This created a need for dependable and economic means of transportation, a need that was met by constructing an extensive system of canals. A little later on, the first of the coalfield railroads were built. Both of these types of structures called for the use of tow lines, and out of this requirement there grew the wire-rope industry. Thus did anthracite pay its debt.

White & Hazard also contributed notably to the development of the canal system. This came about through a natural chain of events. Finding difficulty in obtaining the newly adopted coal, save at great expense, they purchased a large tract of coal-bearing land near Mauch Chunk, on the Lehigh River, in 1817. In the same year they leased, for 20 years, the property of the Lehigh Coal Mine Company, which was then idle. They agreed to mine 40,000 bushels of coal annually for use in their wire mill and to "pay, upon demand, one ear of corn as annual rent of the property." This was apparently a one-sided bargain, but the lessors believed that the setting up of transportation facilities to move the coal to Philadelphia, and the development of a market, would result in a marked increase in the value of their property.

In 1818, White & Hazard succeeded in having an act passed by the Pennsylvania Legislature which authorized them to improve the navigation of the Lehigh River in order that they might deliver their



WIRE-ROPE SECTIONS

There are about 80 different constructions, of which not more than 25 are in general use. A 6x7 rope is one having six strands which, in turn, are each made up of seven wires. The center, shown in black, is in most cases a hemp rope. For certain severe service conditions, it is made of metal. A few of the simpler constructions are shown here.

40,000 bushels of coal annually to Philadelphia via the Lehigh and the Delaware. Commentators of that day expressed the opinion that they really were securing the privilege of "ruining themselves," because several previous attempts to make the Lehigh navigable had failed and it was the common belief that the objective was impossible of accomplishment. The Lehigh falls rapidly, its bottom is exceedingly rocky, and at certain times of the year its flow is so small that it will float only small craft. Undaunted by what had gone before them, however, White & Hazard, together with a temporary partner named Hauto, tackled the task with their full energy. They took soundings, blasted out rocks, and straightened channels, only to have the river reach an unprecedented low stage in 1818. They had agreed to bring about "a navigation downward once in three days for boats loaded with 100 barrels or ten tons." Seeing that this would be impossible, Captain White met the situation by devising a series of crib dams having an easily maneuvered lock in them for passage of the coal arks. By storing water behind these barriers and suddenly releasing it, there were created waves that bore the vessels onward. These structures were known as "bear-trap locks," and their inventor was hailed as a genius.

Incidentally, White, Hazard and Hauto founded the town of Mauch Chunk. The first child born there was a boy that arrived at the home of the steward of the local inn in 1820. A celebration was held and the infant was named Josiah White Erskine Hazard George F. A. Hauto Brink. Strange to say, the boy lived. In later years, White & Hazard built a blast furnace at Mauch Chunk for smelting iron ore with anthracite coal, and in 1846 they moved their wire and wire-rope mill there in order to get closer to their source of fuel.

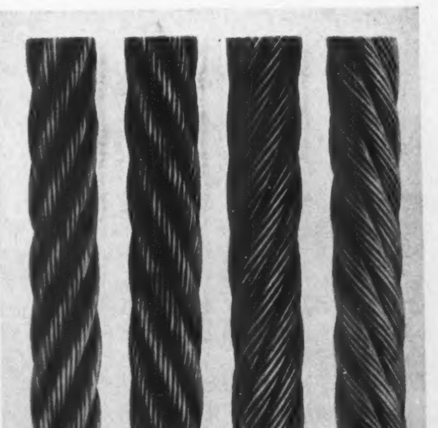
For improving the Lehigh River, White & Hazard had formed the Lehigh Navigation Company in August of 1818. Two months later they organized the Lehigh Coal Company for the purpose of building a road from the river to their mine over which to haul their coal. This undertaking was likewise called impossible, owing to the ruggedness of the section that had to be traversed, but the road was completed in 1819. On April 1, 1820, the two companies united under the name of the Lehigh Navigation and Coal Company. In the following year, it was changed to the Lehigh Coal and Navigation Company. It is now known as the Lehigh Navigation Coal Company. During 1820, a total of 365 tons of "Lehigh" coal was delivered from the mine to Philadelphia. This was the first shipment of anthracite by a company that is still engaged in the business. The Lehigh Navigation Coal Company remains an important factor in the anthracite industry, and the trade name "Lehigh" still designates its product.

The wagon road just mentioned became America's first steam-powered railroad. By 1827 it could no longer adequately handle the traffic over it and was laid with rails. It was nine miles long and had a grade of 100 feet to the mile. The rails consisted of wood, faced with strap iron, which was nailed on through holes laboriously drilled by hand. Ties were spaced four feet apart. The cars held only one and one-half tons each. From six to ten of them at a time made the descent by gravity. They were hauled back by mules that rode down on specially built cars. It is recorded that the mules seemingly enjoyed the trip and objected strenuously if they were made to descend the mountain under their own power. After a short time, the line was converted to steam operation, engines at the summits of the several inclines or planes drawing the empty cars up by means of tow lines. They continued to make the descent by gravity. This railroad was considered an engineering marvel.

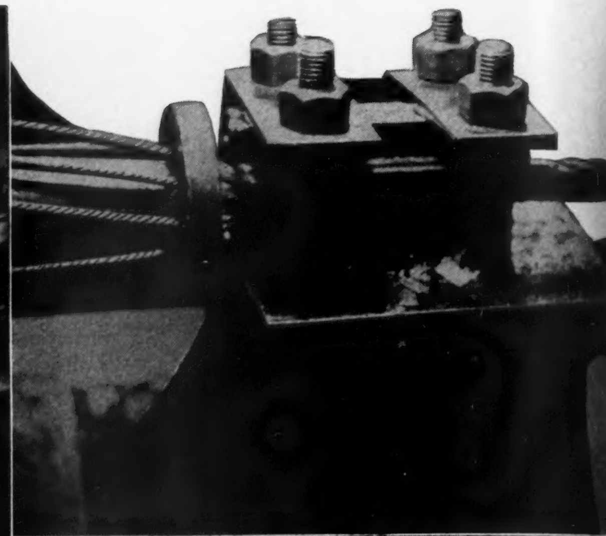
Although, as we have seen, the Lehigh River was made navigable for coal arks or barges, this mode of transportation was not satisfactory. The boats were made of wood, assembled with spikes, and joined together into a train by iron hinges. Upon arrival at Philadelphia, they were broken up and the lumber sold, the nails and iron being returned to Mauch Chunk for re-use. Within a few years, 400 acres of forest land was being cut over annually to supply lumber for the boats. Meanwhile, the Schuylkill Navigation Canal was being built from Pottsville to Philadelphia, and upon its completion in 1825 vast quantities of coal began to move through it. As it provided a slack-water route the entire distance, the boats were towed back and forth and used over and over. Manifestly, the Lehigh-Delaware river system could not compete with this new waterway and, by legislative act, the canalization of the Lehigh and Delaware was begun. Captain White supervised the excavation of the Lehigh branch. He already had built the first canal in Pennsylvania, a short one at Falls of Schuylkill that had two locks. The Lehigh Canal was opened in 1829 and the Delaware Division Canal three years later, providing slack-water transportation from above Mauch Chunk to Philadelphia. At Easton, Pa., they connected with the Morris Canal that extended to New York.

THE VARIOUS "LAYS"

The "lay" of a wire rope has to do with the manner of its winding. In "Regular-Lay" rope, the wires of the strands are wound in the opposite direction to that of the strands themselves. In "Lang-Lay" rope, individual wires and the strands are wound in the same direction. If the strands are wound toward the right, the rope is "Right-Lay"; if to the left it is "Left-Lay." "Right-Lay" is most often used. Note that a greater length of individual wires is exposed in "Lang-Lay." It is therefore preferable, but was formerly considered "cranky" and hard to handle. The invention of preformed wire rope overcame this objection by relieving internal stresses that promoted obstinacy of behavior.



Right-Lay Regular-Lay | Left-Lay Regular-Lay | Right-Lay Lang-Lay | Left-Lay Lang-Lay


STEPS IN MAKING WIRE ROPE

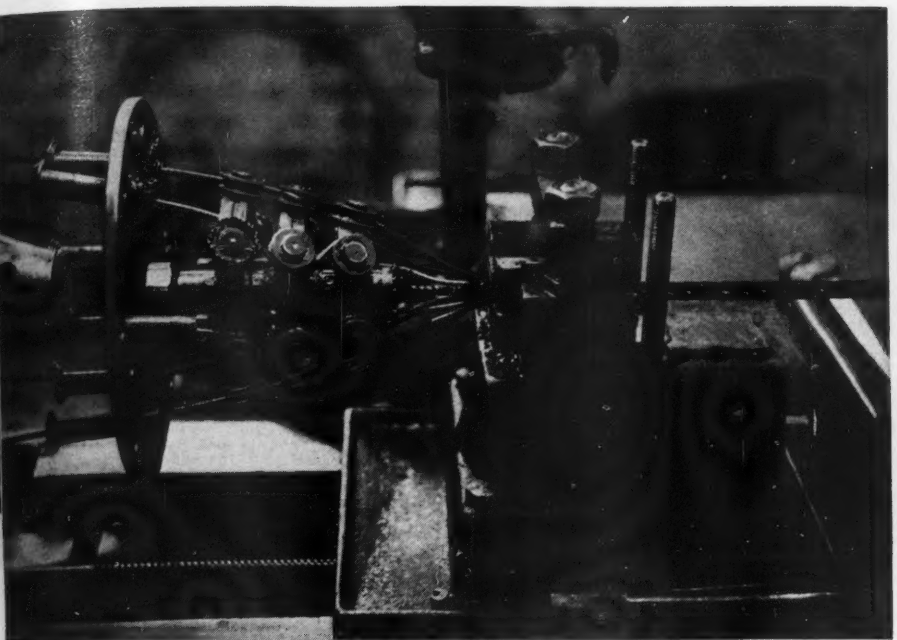
Wire is first drawn to the desired size by pulling it through dies (just above). These wires are next twisted into strands by revolving machines (left). The strands are then wound around a core of hemp rope by a similar process. Conventional wire rope is made by simply twisting the strands as shown at the top, center. In making preformed wire rope, each strand is preshaped into the helical bend it will take after being wound. In one type of machine (right) this is done by intertwining them among three small sheaves set in line just back of the point of twisting.

These artificial waterways and others, shown on an accompanying map contributed materially to the development of the anthracite regions. The Lehigh-Delaware system, save for the upper stretch of the Lehigh, is still maintained in operating condition, but is seldom used.

Mention was made previously of the demand for wire rope in connection with canals. This referred primarily to those inland waterways that crossed rolling country rather than to those that followed river valleys. The former type really consisted of a series of canals connected by portages over the intervening higher areas. It was the practice to draw the boats up one side of a plane and lower them on the other side by means of stationary engines installed at the top. For this service the early canals employed hempen cables. These ranged from 6½ to 9 inches in circumference and up to a mile in length, some of them costing as much as $3,000. As they wore out quickly, their renewal constituted a burdensome expense. Observing this while employed as an engineer by the State of Pennsylvania, John A. Roebling, then 35 years old, suggested substituting wire rope, concerning the manufacture of which he had read in a foreign technical journal. The State Board of Public Works was skeptical about the idea, as wire rope was unknown in this country. Finally, however, they gave in to the extent of agreeing to test such a rope if Roebling would build one. This he proceeded to do on his farm at Saxonburg, Pa., utilizing hand labor. Needless to say, the new material was highly successful, and wire rope was adopted for the portages on various of the Pennsylvania canals.

Meanwhile, with the eastern part of Pennsylvania gridironed with canals that carried great tonnages of anthracite coal to diversified markets, men began to envision railroads, which were already in use in England. Maurice and William Wurts, who had built the Delaware and Hudson Canal to provide an outlet for coal produced in the Wyoming and Lackawanna valleys, conceived the idea of constructing a railroad from the mines near Carbondale to the western terminal of the canal at Honesdale. In January of 1828, they sent one of their engineers, Horatio Allen, to England to buy four locomotives and the required iron for the rails. This he did, and on August 8, 1829, he piloted the *Stourbridge Lion* over the line on the first journey ever made by a locomotive in this country. It was the general impression that the hemlock rails, faced with iron strap, would break down under the weight of the belching monster, or that the least that could happen would be for the locomotive to leave the tracks at the first curve. Accordingly, Allen decided to expose no one to the imagined hazards and made the trip alone. He traveled some three miles, reversed the engine and returned to the starting point without mishap, but convinced himself that the track would have to be strengthened if regular service were to be inaugurated. This was apparently never done and, save for a second test run by Allen, the locomotives saw no service. They did, however, serve to introduce steam traction in America and to pave the way for the early construction of numerous railroads that fulfilled their missions.

Among the early railroads was one that is germane to our story for several reasons. It was built to transport coal, and its operation was made possible by the development of wire rope. Moreover, it is in regular use at present, moving millions of tons of anthracite a year, and its design remains unchanged after 93 years of service. The



original line extended from Wilkes-Barre over the intervening mountain range to White Haven, where a connection was made with the Lehigh Canal, thereby providing an additional route for transporting coal from the Wyoming Valley to the Atlantic seaboard. The Lehigh Coal & Navigation Company was authorized by an act of the Pennsylvania Legislature in 1837 to build this connecting link, and it was completed in 1843. Although it was accorded acclaim as an engineering achievement partly because it included a tunnel nearly one-third mile long on the eastern flank of the range, we are here chiefly interested in the scheme that was devised for surmounting the western slope. It is in the form of a series of three inclined planes up which the cars are drawn with ropes by means of power supplied by stationary steam engines at the top of each slope. The three planes have respective lengths of 5,000, 3,000, and 3,700 feet—a total of 11,700 feet. The average rise per 100 feet varies from 5.7 feet for the lowermost plane to 14.65 feet for the middle one. The total rise from the lower end at Ashley, near Wilkes-Barre, to the summit at Solomon's Gap, is 1,013.75 feet. The total distance is 13,020 feet, there being 1,320 feet of connecting track between adjacent planes. In 1862, the upper portion of the Lehigh Canal was destroyed by flood and the state legislature prohibited its restoration but granted a charter for the construction of a railroad to replace it. Another act in 1864 extended the line to Easton, Pa., where it connected with the Central Railroad of New Jersey to form a through route from Wilkes-Barre to New York. The line from Easton westward was called the Lehigh and Susquehanna Railroad, but in 1871 it was leased to the Central Railroad of New Jersey, which has since operated it.

Until 1867 all traffic, both freight and passenger, passed over the Ashley Planes. In that year there was completed a "back track" from the summit of the mountain to Wilkes-Barre, which is now the main line of the railroad. To attain a grade that locomotives could negotiate, it was necessary to build 12.47 miles of track as compared with the plane distance of 2.47 miles. Accordingly, although all passenger cars and empty coal cars are routed by the main line, the planes are still used to transport coal and, to some extent, other freight to the summit.

As will be readily surmised, strong, durable wire rope is a requisite for the operation. The main cables are $2\frac{1}{2}$ inches in diameter and have respective lengths of 4,640, 3,670 and 5,780 feet. White & Hazard manufactured the first rope used on the planes, and either they or their successor, The Hazard Wire Rope Company, made all those subsequently employed excepting one. One of them gave six years of service, during which period it hauled approximately 18,500,000 tons. One that is currently in use has hauled more than 17,000,000 tons within a period of five years.

We have seen now how anthracite coal assisted in starting two prominent wire-rope builders of today. There were, of course, other contributing factors, and among these was the introduction of suspension bridges. The first of such structures in which wire was the supporting material was erected by White & Hazard across the Schuylkill River in 1816. The cables were composed of six $\frac{3}{8}$-inch wires drawn in their mill and extended from the factory building on one side of the river to two large trees on the opposite bank. This bridge was 410 feet long and had a board floor only 18 inches wide. It was intended to support not more than six or eight persons at a time, but an old newspaper clipping quotes a man as saying that he saw "thirty people on it, including rude boys running backward and forward." The total cost of the structure was $125, and a toll of one cent was charged to cross it. Subsequently, much of the production of wire factories went into cables for suspension bridges, and this field still remains an important one.

Mention was made earlier of the building of wire rope by hand on the Roebling farm. This "rope-walk" method continued to be used for a number of years. The first machine for forming wire rope was invented by Erskine Hazard and his son, Fisher, shortly after the Mauch Chunk mill was established in 1846. The Hazard factory was subsequently moved to Wilkes-Barre. There, with the aid of modernized machinery, is made wire rope of many types of construction that is designed for some of the innumerable uses to which this material is put. There are at least 80 different constructions of wire rope, but three-fourths of them are termed special and are designed to meet unusual conditions of service. A few of the standard types are shown in an accompanying illustration.

The process of making or "laying up" a wire rope consists of three essential steps: first, drawing and treating the wire from the rod; second, twisting or spinning these wires into strands of the desired size and construction; and third, twisting or "closing" several strands around a hemp or wire-rope center. The use of hemp, rather than wire, for the center increases the pliability of the rope and gives it longer life, especially where the service conditions subject it to recurrent bending or flexing. For certain requirements, such as where extreme heat is experienced, or where the rope is subjected to great crushing pressure, the core is made of wire. It is now generally recognized that lubrication greatly lengthens the service life of wire rope, and as the hemp center acts as a reservoir for the lubricant this is an added reason for using it.

The raw material for wire making is hot-rolled rod that is supplied in coils by steel mills. The metal employed may be iron, traction steel, cast steel, mild plow steel, plow steel, or improved plow steel, depending upon the use for which the rope is intended. Improved plow steel has a nominal tensile strength of from 240,000 to 260,000 pounds per square inch, and rope made from it combines great strength and toughness with abrasive resistance.

The first operation in the wire mill is to immerse the coiled rod in a solution of sulphuric or hydrochloric acid to remove the scale. After this "pickling," it is washed by water sprays and placed in a lime solution. The lime neutralizes any remaining traces of acid and also imparts a coating that is beneficial to drawing. Finally, the rod is baked in a gas-fired oven for several hours, and is then ready for drawing. This consists of pulling the cold wire through a tapered opening in a die made of tungsten carbide, thus reducing the diameter of the wire and at the same time lengthening it. The amount of reduction per pass and the number of times the wire is drawn through

CRADLE OF WIRE ROPE

Canoeists carrying their boat up one of the inclines on the Morris Canal, which was used until a few years ago. There were 22 of these planes on this waterway that extended from Easton, Pa., on the Delaware River, to Jersey City, N. J. DeWitt Clinton and Robert Fulton were among its apostles. It was opened in 1831 and transported coal and other freight to New York until railroad competition forced its abandonment. It was given to the State of New Jersey in 1923. The picture shows some of the wire ropes that were used to haul canal boats up the plane. It was for such service on the various inland waterways that much of the first wire rope was made in this country.

progressively smaller dies have a profound, but differing, effect upon the physical qualities of each grade. Accordingly, the drawing operations vary with the stock used.

Repeated drawing develops stresses, and to relieve these the wire is passed through either a heated air chamber or pans containing molten lead. This resets the crystalline structure of the steel. The operation is known commercially as patenting. Before a wire is reduced to final size it may receive two such heat treatments. The size of the finished wire will vary, of course, according to the size of the rope in which it is ultimately to be incorporated. The range in diameter is from .005 inch to .25 inch.

The assembly of wire into strands is done on one of two types of machines. In either case, spools of wire are mounted on the periphery or along the axis of a cylindrical framework which is conical at one end. The twisting is imparted by revolving the framework, the wires being brought together at the forward end of the cone. Just prior to the twisting process, each wire passes through a lubricant. In the gravity type of machine, the spools of wire are mounted in cradles and remain stationary. In the planetary type of machine, the spools revolve with the rest of the frame. These machines run at speeds up to 1,800 rpm.

The strands thus formed are fashioned into finished wire rope in the manner just described and by machines of similar nature. In this case, however, the strands are twisted around the central core which, as already stated, is usually of hemp. This is first led through a reservoir of lubricant at the rear of the machine, then through the center of the cylinder, emerging through the forward end of the cone down the face of which the strands are led just prior to the twisting operation. The finished rope passes through a die, assembled in two halves, that squeezes the section to the prescribed size. The accuracy of this operation is such that the variation in diameter is normally only about one one-thousandth of an inch.

The foregoing description pertains to the making of conventional types of wire rope. There is an additional step when the product is what is known as preformed wire rope. As the name implies, preformed rope is made up of strands that have been formed or flexed into the shape that they assume in the finished rope. The importance of this preforming will be readily apparent, and its influence upon the service life of wire rope is great. As is well known, in the ordinary wire rope, the strands are forcibly held in their helical position. Whether idle or working, they are constantly attempting to straighten out. In other words, the rope is always under tension and never at complete rest. This internal stressing accentuates fatigue, which causes individual wires to break before they are worn through.

In making preformed wire rope, the helical shape which the strands will assume in the rope is imparted to them prior to the twisting operation. This results in a rope in which the strands are at rest; there is no straining of one against the other; friction is reduced greatly; and the rope consequently lasts longer. This notable improvement in wire-rope construction was developed by the American Cable Company, an associate company of the American Chain Company. It holds the patents, but licenses other manufacturers to use them, and virtually all the leading companies in the field make a preformed wire rope which is sold under their respective trade names.

The shaping of the strands is done in one of two ways. In what is called the quill-and-rope method, each strand is drawn through a spiral-shaped groove in a steel cylinder at the cone head. The other method consists of threading the wire around alternate sides of three small sheaves that are mounted in line on the cone head. In either case, the pretwisting must be done with accuracy to insure a helix that will be of the correct size for the particular diameter of rope being made.

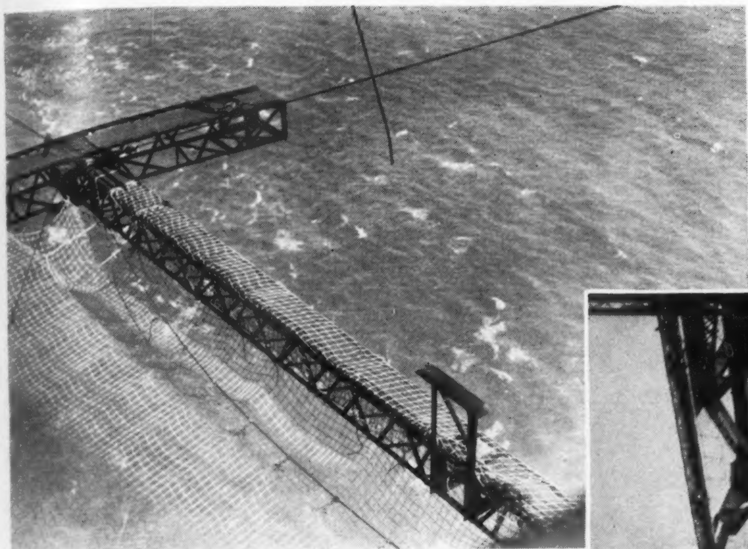
The present field of wire-rope service is so extensive that it would be impossible to name here even the more important uses, but they are so well known to nearly everyone as to require no mention. It suffices to say that wire rope plays an important part in almost every branch of industry.

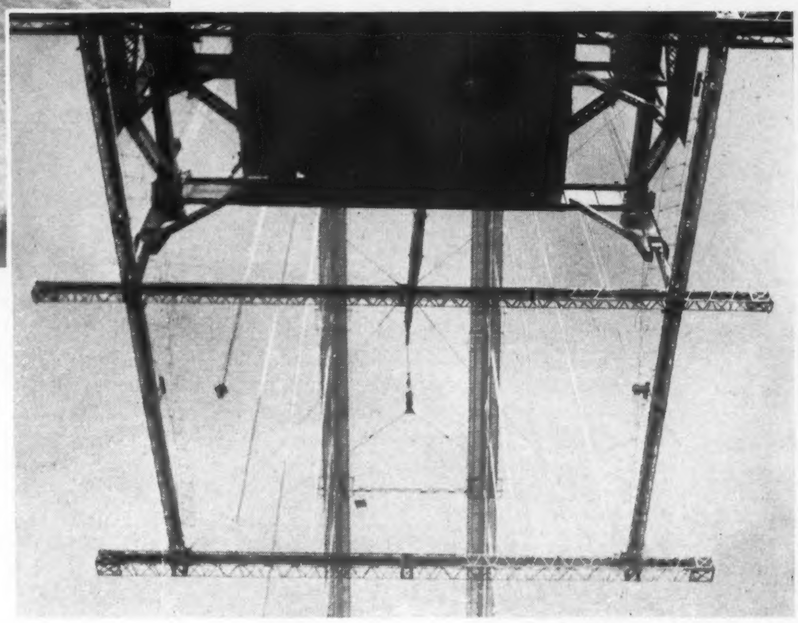
Thanks to the metallurgical advances that have produced stronger steel to work with and to the improvements that the wire-rope makers have instituted in assembling this steel into rope, the finished product is continually increasing in durability. For example, a rope that transports an elevator 50,000 miles is considered very good, but one of Hazard manufacture that was installed on an automobile lift in Chicago ran up a total of 140,000 car miles before being removed from service in 1935.

THE ANTHRACITE CANALS

Before railroads were thought of, this extensive system of waterways was built to transport coal from the Pennsylvania fields (the shaded areas) to the various markets. The Schuylkill Navigation Canal was the first one opened. Work on it began in 1760, but was not completed until 1827. Some of these canals still remain in a good state of preservation.

From "The Story of Anthracite."





VIEWS OF NET

The picture above shows a portion of one of the traveling nets as it appears when looking down upon it. At the right is the same net as viewed from below it. The supporting frame consists of two rectangles of light structural steel. The two parallel vertical strips are the catwalks beneath the main suspension cables.

Safety Net Protects Bridge Workers

A RECORD for safe construction is being made on the $35,000,000 Golden Gate Bridge, the largest suspension-type bridge yet authorized. From the inception of the work, safety precautions have been stressed, with the result that the erection of the suspension towers from foundations 100 feet below sea level to a height of 746 feet above water and the placing of the main cables and suspenders have proceeded without a single fatal accident. Now that the work on the actual bridge structure has started, there has been brought into use an innovation in safety devices. It is a net, similar to those spread beneath circus aerialists, that will protect steel erectors and other workmen from injury in case they fall. Instead of plunging more than 200 feet to almost certain death, they will be caught, unhurt, a few feet beneath the structure.

The net is of 6-inch mesh and made up of ⅜-inch Manila rope. Instead of being tied, as is the case with smaller nets, the ropes are held together at intersections by special metal clamps that were devised for the purpose. Approximately 3,000,000 of these clamps were required in forming the 700,000 square feet of net—an area sufficient to cover 16 football playing fields. The cost of the net is placed at $82,000; but all those identified with the bridge construction are agreed that this expenditure is justified by reason of the safety it assures. It is their aim and hope to complete the bridge without sacrificing a life. It is estimated that without this precaution as many as 25 men might fall to their deaths. In all probability the presence of the net will give the men a greater sense of security that will speed up the work and thereby save at least a portion of its cost.

Four traveling nets are employed, and as these move along with the steel erection permanent nets are put in place. The latter will remain until all paving, painting, and electrical work has been completed. Each traveling net is supported on a light metal frame that is hung from 22-inch trolley wheels that run on the top chord of the bridge structure. The net is 120x117 feet, and is placed with its greater dimension running crosswise of the bridge. It extends several feet beyond the most advanced working point, and as the bridge floor will be 90 feet wide it also extends 15 feet beyond the sides.

At the rear of the net frame is a platform 4 feet wide and running the full 120 feet of the net's span. From this platform 50-foot lengths of the permanent net are paid out and tied to the under part of the bridge structure as the traveling net advances. Each 50-foot section, correctly furled and packed, is hoisted to the platform and there stretched out to its full length. The various layers are arranged so that they will pay out without fouling one another. The traveling net moves forward 8 feet 4 inches at a time, and at each stop the permanent net is secured to the bridge pennants with tie ropes. After six moves a 50-foot section is in place, and then another one is raised to the platform and the procedure repeated.

The mesh of the net is large enough to permit hot rivets to fall through. To prevent these and other hot materials from setting the net afire, the strands of the rope of which it is composed were fireproofed during the manufacturing process. This involved the treating, with suitable chemical solutions, of approximately 3,500,000 feet of rope. The strands were likewise weatherproofed. All netting must meet the blow-torch test of the San Francisco Fire Prevention Bureau. The rope was fabricated by the J. L. Stuart Manufacturing Company and treated by the Tubbs Cordage Company.

The decision to use safety nets was reached as a result of hearings conducted by the California Industrial Accident Commission. The order issued by that organization was concurred in by the Bethlehem Steel Company, contractors for the superstructure, by the consulting engineers, and by officials of the Golden Gate Bridge & Highway District. The frames for the traveling nets were designed and erected by the Bethlehem Steel Company.

An Underwater Drilling Job in the Kongo

DRILLBOATS are so generally used in American waters for breaking up subaqueous rock that other equipment is seldom considered for extensive operations. In some other parts of the world, however, the true effectiveness and economy of the drillboat are only now becoming known. For that reason, an account of its successful employment for an underwater excavation job in connection with harbor improvements in the Kongo Free State is of interest. The work was described in the German publication, *Die Bautechnik*, from which the following facts have been abstracted.

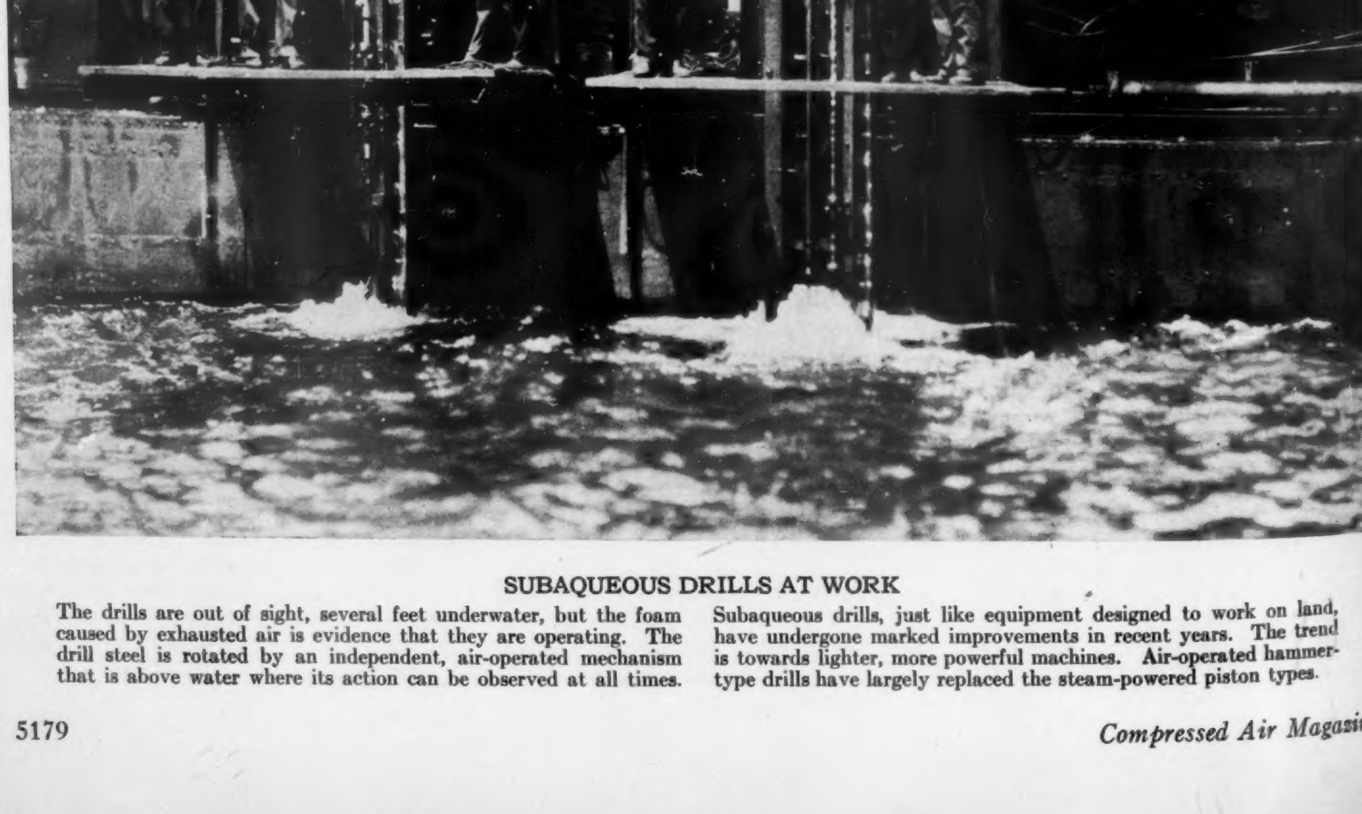
The problem was to remove a submerged ledge that extended up to within 10 feet of the mean-low-water surface at a point almost in the center of the harbor, and which was therefore a menace to shipping. The object was to reduce the elevation of this high area sufficiently so as to provide 26 feet of water over it, that being the controlling minimum depth in other parts of the harbor. This called for the excavating of approximately 10,500 cubic yards of rock.

There were certain physical difficulties that complicated the execution of the work. The harbor is at the mouth of a river that is nearly 4,000 feet wide at that point. It abounds with crocodiles, and the current running over the working area was so strong at times as to be termed violent. The region is one that is often visited by tropical hurricanes that come with great suddenness. It was necessary that blasting operations be controlled so as not to interfere with shipping, which meant that shots would sometimes have to be fired within 200 feet of cargo steamers and passenger boats that plied the harbor.

Various possible methods of removing subaqueous rock were considered, such as employing divers in a diving bell, breaking the rock with falling chippers, etc. In view of the conditions just mentioned, however, it was decided that only a drillboat would suitably answer the requirements. Inasmuch as no work of a comparable nature had been done in Europe in recent years, the selection of equipment was based upon the experiences of leading contractors with similar operations in the United States.

A 2-drill boat was determined upon, and was constructed with a length of 115 feet, width of 40 feet, hull depth of 6½ feet and draft of 2 feet. Provision was made for moving the boat and for holding it in place by means of heavy anchors, with attached spring lines which were operated with compressed-air hoists. Once the boat was spotted for drilling, it was held at that position by lowering spuds that slid in housings at each of the four corners. These spuds were steel columns 58 feet long. By means of suitable mechanisms, operated by powerful compressed-air hoists, it was possible to raise the boat on these spuds to a height that insured quiet and secure operation during the drilling and loading of holes.

An air compressor of 620 cfm. displacement that was driven by a 165-hp. diesel engine, and a modern blacksmith shop for reconditioning drill steels were installed on one side of the boat. The drilling equipment was placed on the other side. Three rails that ran the entire length of the hull were provided for moving the two drill towers. Each tower was 59 feet high. Running in guides on each tower was a drill column, which terminated in a sand pipe at the bottom. Running in guides on the drill column was the drill ladder, on which the drill was mounted.



SUBAQUEOUS DRILLS AT WORK

The drills are out of sight, several feet underwater, but the foam caused by exhausted air is evidence that they are operating. The drill steel is rotated by an independent, air-operated mechanism that is above water where its action can be observed at all times. Subaqueous drills, just like equipment designed to work on land, have undergone marked improvements in recent years. The trend is towards lighter, more powerful machines. Air-operated hammer-type drills have largely replaced the steam-powered piston types.

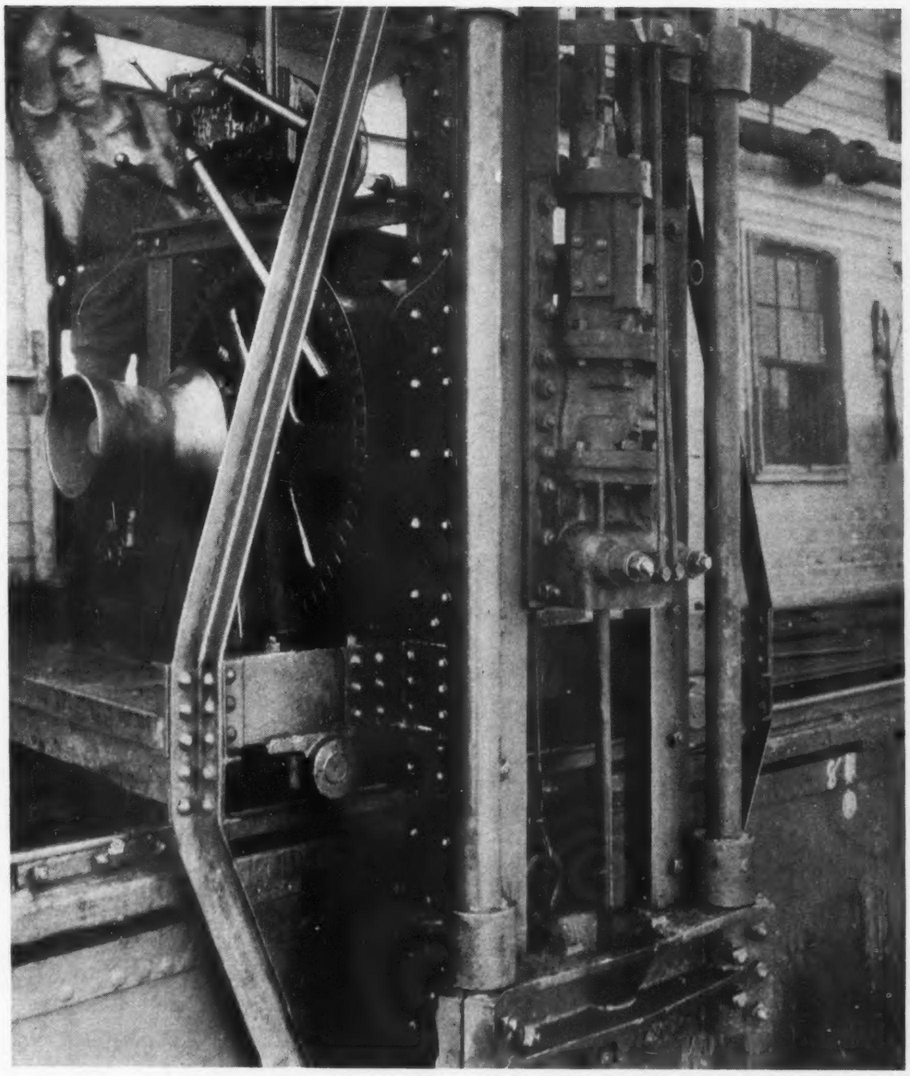
The drill chosen was the Ingersoll-Rand Type X-80. This is a hammer type of drill that operates with compressed air. Being submergible, it works close to the rock being drilled. This eliminates the necessity for very long drill steels and correspondingly reduces the loss in impact force upon the bottom of the hole being drilled. This, together with its other advantages over the older piston-type drill, results in faster drilling speed and greater simplicity of operation. The X-80 uses hollow drill steel which is rotated by an independently operated air motor located above the water line.

The purpose of the sand pipe is to keep the overburden out of the drill hole. With the aid of a jet of high-pressure water, the sand pipe is lowered through the unconsolidated material until it rests directly upon the rock to be drilled. The pipe is of sufficient length to reach above the top of the overburden. The drill is then lowered under water with the drill steel extending downward inside the sand pipe to the rock surface. In the case under discussion, 1½-inch hollow drill steel was used with forged 4-point bits. The diameter of the starting bits was 3⅞ inches.

Holes ranged in depth from 6½ to 13 feet and were spaced from 4 to 10 feet apart, depending upon the nature of the rock. The latter was somewhat complex in character, consisting of hard gneiss, large bodies of pure quartz, and bands of chlorite slate, which was sufficiently decomposed so as to render it an almost clayey green mass.

Holes were loaded with explosive by the aid of a conventional steel loading pipe having a length of 40 feet and an interior diameter of a little more than 3 inches. After the drill had been removed, this pipe was lowered through the sand pipe until it had penetrated the drill hole about 20 inches. The explosive was 93 per cent blasting gelatine packed in zinc-tin boxes holding one kilogram (2.2 pounds) each. Two or more boxes were bound together with hempen cords. Because of the swift current, considerable difficulty was at first experienced in guiding the loading pipe into the unseen sand pipe, but this was overcome by directing its course downward along the drill column.

From 10 to 12 holes were blasted at a time, the firing being done electrically. Owing to the current, great trouble was encountered in keeping the charge in the holes until the instant of blasting, and in spite of careful procedure it frequently happened, especially in the beginning, that one or more holes failed to fire. In such cases, mines were used to detonate them. The locations of the misfires were determined as nearly as possible by exact measurements with a view to lowering the mines directly over them. It was usually found that the desired result could be obtained if a mine was deposited within 10 feet of a non-exploded hole. Whenever any doubt existed as to whether or not a hole had been blasted, a new hole was drilled at a point about 3 feet away. When this was loaded and fired, the explosive in the original hole was also set off.



X-80 DRILL AND ITS MOUNTING

A close view of a modern, submergible, compressed-air drill of the type used for the work described in the accompanying article. The entire drill derrick travels on rails along the edge of the boat. The drill moves up and down with the drill ladder, which runs in guides on the drill column. Here the drill steel is shown entering the funnel leading to the sand pipe that prevents the overburden from getting into the hole during drilling.

The foregoing shows the necessity that existed for keeping a careful record of the locations of all holes. Considering the width of the harbor and the velocity of the current, this called for painstaking procedure. After some experience had been gained, it was possible to estimate whether too much or too little explosive had been used by noting the height to which the column of water was thrown by the blast and by observing the degree of muddiness of the water immediately after shooting. More exact information on this point was gained, of course, when dredging of the broken stone was started.

Working one shift a day, approximately 2,600 cubic yards of rock, measured in the solid, was drilled and blasted each month. This performance was considered highly satisfactory. It was estimated that the progress per shift was 24 times as great as it could possibly have been with a diving bell. Moreover, the cost of wages and materials was computed to be only one-sixth as much. There was also the added advantage for the method adopted that it permitted the work to proceed with only insignificant hindrance to the free movement of shipping. The cost of the drillboat, fully equipped, was approximately $104,000.

It is predicted that numerous rock-removal jobs in harbors and navigable rivers of various parts of Europe that have been deferred because of the high costs of previously used methods will now be brought up for reconsideration in view of the gratifying results obtained in this instance.

The work described was done by the German contracting firm of Dyckerhoff & Widman, in conjunction with the Belgian firm of Cogetra. The operations were directed by K. Petrini.

LIFE OF DRILL RODS

ONE of the outstanding developments in rock-drilling practice in recent years has been the introduction of detachable bits. For many types of drilling such bits represent a distinct gain in economy and convenience over the previously used 1-piece steels. But, while they constitute a definite improvement, detachable bits cannot be considered a cure-all for drill-steel troubles. Users of rock drills should bear in mind that even steel has its limitations.

One of the important advantages of detachable bits is that they eliminate the necessity of regularly transporting long, heavy steels back and forth between drilling locations and blacksmith shops. This has materially reduced the stock of drill steel that is required to keep a job going and has effected savings in the blacksmith shop.

Reports from the field indicate that some drilling operations are experiencing what seems to be a too heavy breakage of drill rods. Upon analysis, however, it will be found that in most cases the difficulty can be attributed to failure to stock a sufficient quantity of drill rods. Sometimes the salesman is to blame, his enthusiasm having led him to underestimate the needs.

When solid steels are used, it should be borne in mind that they are in actual service only a few minutes at the most and that they are then removed from the scene for a period of from several hours to several days. As a matter of fact, a given piece of steel may be used only three times a week. If it does not break for three months it appears to have lasted a long time, although its service life may aggregate only three or four hours. On the other hand, when detachable bits are employed, the drill rods stay on the job, and each of the different lengths is used over and over during each shift. In two or three days a rod may be subjected to service that is equivalent to the 3-months' service of the solid steel just referred to.

Experience indicates that even with the best drill rods obtainable breakage can be expected after an average actual drilling period of 200 minutes. The failure may occur in the shank, in the threaded portion, or in some intermediate section of the rod. This figure is based on drilling in very hard rock: for softer varieties the period will be longer. In soft limestone, for instance, a drill rod will apparently last indefinitely. Aside from the hardness of the rock, there are many variables that will affect the service life of drill rods. Chief among these are the size of the drill, the air pressure, the size of the bit, and the diameter of the rod itself.

An apparently safe rule to follow is to provide drill rods having an aggregate weight of at least 25 per cent of that of the solid-forged drill steel which would be required to keep the same job going without the risk of a shortage. Another way of figuring is to expect one drill-rod failure for every 60 bits used when drilling hard, abrasive rock. If no reshanking and rethreading facilities are available on the job, drill rods should be provided on the basis just outlined to keep the work underway. If these facilities are at hand, then the supply of drill rods can be proportioned so that there will be one rod for every 100 bits in use.

PRESERVATION OF FOODS

THE Food Investigation Board of the Department of Scientific and Industrial Research in Great Britain has been finding out some surprising things about the conservation of fresh foodstuffs. To determine the procedure for best preserving a particular animal or vegetable product in its original state, it is necessary to know the physiological and the chemical composition of that product. Consequently, the board has been applying scientific methods to the problem, which it has been studying since 1917.

This research has established the fact that the protein myosin controls the changes that take place in the flesh of animals and fish when they are killed and also during their storage. In eggs, it is another protein, mucin, that is the key substance. The determination of effective methods of storing these products therefore resolves itself largely into a minute examination of the nature and behavior of these two proteins.

The board has learned that the nonfeeding of a pig during the 48 hours preceding its slaughter serves to increase the thickness of its bacon-producing part. It has found that if a pig is kept relatively cool for 24 hours before it is killed, the muscles of its carcass will have low electrical resistance, a property that promotes the penetration of salt during the curing process. Farm-killed pigs yield better bacon than factory-killed animals, one apparent reason for this being that the shaking of the carcass during transportation to market has a beneficial effect on it. Artificial shaking of factory-killed pigs has been tried, but does not give the same result.

Some persons object to gas-ripened fruit, yet it has been discovered that the natural ripening of bananas and apples is induced by ethylene gas generated by them. Investigations based on this fact have disclosed that artificial ripening of green fruit can be started by passing over it a current of air containing one part per million of this gas. Experiments in controlling the oxygen- and carbon-dioxide contents of the atmosphere of fruit storage rooms have led to the conclusion that pears can be preserved without decay for periods up to six months.

To facilitate its studies, the board has set up laboratories in various parts of the British Empire where the principal products originate. While much remains to be learned, the progress made thus far has prompted the prediction that we shall ultimately be able to keep fruits and vegetables fresh from one growing season to the next.

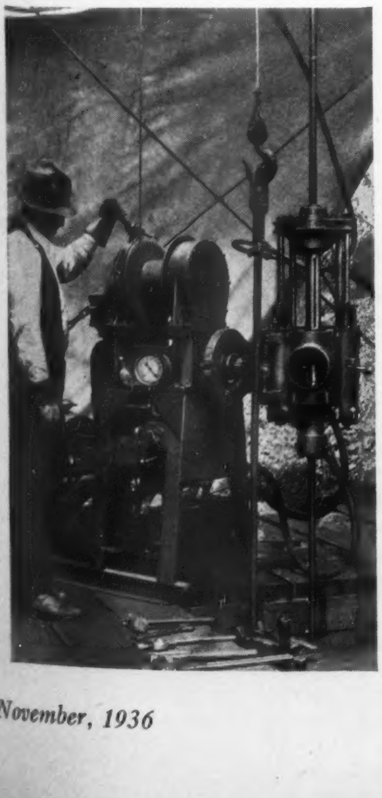
Industrial Notes

Duralumin, because it combines strength and lightness, has been used by Vickers-Armstrong for the construction of a 4-deck skip for one of the deep gold mines in South Africa.

Isorel is the name of a substitute wood of French manufacture that is suitable for interior use. It consists of wood fibers and synthetic resins, which are pressed into sheets of varying dimensions. The material is said to be elastic and homogeneous, and to be proof against moisture as well as sound.

NEW DIAMOND DRILL

INGERSOLL-RAND Company has released for free distribution a 4-page bulletin descriptive of its "Coroc" diamond drill. This drill is equipped with a master gauge that registers directly in pounds the pressure of the diamond bit against the rock. Thus, when a soft formation or seam is encountered during drilling, the reaction is immediately indicated on the gauge. The hydraulic control mechanism permits the drill, under such conditions, to accelerate its feed, but it does not allow the string of tools to drop. The drill can be operated by gasoline or kerosene engine or electric-motor drive. Raising of the tools is facilitated by an integral hoist that is especially well suited for the work. With the "Coroc" diamond drill it is possible to put down holes up to 1,150 feet deep providing cores $\frac{7}{8}$ inch in diameter, or holes of lesser depth but larger cores measuring up to 3 inches in diameter. Those interested can obtain a copy of the bulletin, No. 2231, from any of the company's branch offices or its main office at 11 Broadway, New York, N. Y.



In the well-organized pressroom of the King-Seeley Corporation, of Ann Arbor, Mich., each of the 40 presses is supplied with compressed air to remove the finished part. This is fairly common practice: the interesting feature is the delivery of the work at the front and not at the back of the machine, as is generally the case. This is effected by means of a pipe into which the individual pieces are blown and down which they drop by gravity into a box immediately below the feed box. The object is to facilitate handling and to save space.

OUR COVER PICTURE

THE unusual photograph was taken at Lake Rose Mines, 75 miles north of Senneterre, in northwestern Quebec. In that isolated location, wood is the only fuel available, and the nearest stand of timber is about 2 miles away. The three "Husky" dogs haul about one quarter of a cord per trip. Needless to say, their job is one of the most important at the mine.

To provide herself wherever possible with materials from within, Germany is experimenting with the residue of the wine industry in an effort to find substitutes for vegetable oils. It is reported that the investigators are meeting with success, and that three different kinds of oil are being produced from the residue, from the fermented grape skins, and from the kernels, respectively. The product obtained from the latter is not good for edible purposes, but is suitable for use in making soap, paint and varnish, linoleum, leather, etc.

Facts About Metal Polishing is the title of an attractive booklet of 39 pages recently published by Norton Company of Worcester, Mass. It is well illustrated and covers the subject point by point in concise language. After explaining what metal polishing really is, it takes up the questions of abrasive grain, glue, polishing wheels and belts, and drying, concluding with several pages on the requirements of different metals and the conditions they must be in to assure satisfactory results. The booklet can be obtained free of charge from the company.

The Rockwood Manufacturing Company has just issued two new data books covering its V-belt drives. No. 782 is devoted to multiple-groove drives, and No. 783 to fractional-horsepower single-groove drives. The method of presenting the data has been simplified as compared with previous similar publications, and it is possible for a prospective user easily to select the equipment best suited to his needs. Copies of these books may be had upon request to the Rockwood Manufacturing Company, 1801 English Avenue, Indianapolis, Ind.

For fastening flat belts or V-belts, the Sudbury Laboratory is offering a new nonmetallic lacing which is known as Tek-Lace. It has a diameter of only 0.055 inch, which means that the holes that have to be made in the belt to receive it are small enough to prevent cutting the fibers and thus weakening the fabric. Another advantage claimed for the lacing is that it has a tensile strength of 100 pounds, or 50 per cent more than that demanded by Federal specifications for rawhide $\frac{1}{4}$ inch wide and $\frac{1}{8}$ inch thick. It is flexible, embedding itself in the belting so that there is no slipping nor bumping to interfere with power transmission, and is protected by a coating that is oil and waterproof. An ordinary awl or similar tool can be used to pierce the holes; but for quicker and satisfactory service a special instrument with a gauge and channeling device can be obtained for \$2.50. A box of Tek-Lace, sufficient for lacing fifteen 3-inch belts, costs \$1.50.

AGGREGATE FROM WASTE SLATE

BY MEANS of a process developed in Great Britain, slate-quarry waste is being converted into a light-weight aggregate that is said to compare favorably with similar ones now on the market. The raw material is crushed and calcined in a rotary kiln, expanding as much as seven times in volume. The resultant product floats on water, and even though it is very porous it is relatively impervious because its minute cells are bounded by glassy walls. The accompanying picture shows a piece of slate before and after treatment.

Courtesy, Rock Products